THE

BRITISH ENCYCLOPEDIA,

OR

DICTIONARY

OF

ARTS AND SCIENCES.

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ARTS AND SCIENCES.

COMPRISING

AN ACCURATE AND POPULAR VIEW

OF THE PRESENT

IMPROVED STATE OF HUMAN KNOWLEDGE.

BY WILLIAM NICHOLSON,

Author and Proprietor of the Philosophical Journal, and various other Chemical, Philosophical, and Mathematical Works.

ILLUSTRATED WITH

UPWARDS OF 150 ELEGANT ENGRAVINGS,

BY

MESSRS. LOWRY AND SCOTT.

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LIST OF PLATES

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THE

BRITISH ENCYCLOPEDIA.

S.

S, ſ, or s, the eighteenth letter, and fourteenth consonant of our alphabet; the sound of which is formed, by driving the breath through a narrow passage between the palate and the tongue elevated near it, together with a motion of the lower jaw and teeth towards the upper; the lips being a little way open, with such a configuration of every part of the mouth and larynx, as renders the voice somewhat sibulous and hissing. Its sound however varies, being strong in some words, as *this*, *thus*, &c. and soft in words which have a final e, as *muse*, *wise*, &c. It is generally doubled at the end of words, whereby they become hard and harsh, as in *kiss*, *loss*, &c. In some words it is silent, as *isle*, *island*, *viscount*, &c. Used as a numeral, S anciently denoted seven; in the Italian music, S signifies solo; and in books of navigation, S stands for south; S. E. for south-east; S. W. for south-west; S. S. E. for south south-east; S. S. W. for south south-west, &c.

SABBATARIANS, a sect of Christians, chiefly Baptists, who observe the Jewish or Saturday Sabbath, from a persuasion that, it being one of the ten commandments, which they contend are all in their nature moral, was never abrogated by the New Testament. They say that Saturday must at least be deemed of equal validity for public worship with any day never particularly set apart by Jesus Christ and his Apostles. Those of this sect who are what are denominated, Particular Baptists, hold, in common with most other christians of the present day, all the other doctrines of grace, as they are sometimes called, *viz.* the Trinity, Atonement, Predestination, &c. &c.

In our own country, this sect is by no means numerous. They have only two congregations in London; the one of General Baptists, and the other of Particular, or Calvinistic Baptists. In America, however, as we are informed by Morse, author of the American Geography, there are many christians of this persuasion, particularly in Rhode Island, New Jersey, and at Ephrate in Pennsylvania.

This tenet, frivolous and unimportant as it may appear, has contributed its quota to the *odium theologicum* of modern divinity, and has been productive of several weighty controversies. Drs. Chandler and Kennicott; Messrs. Amner, Palmer, and Estlin, in behalf of the Sunday christians; and Mr. Cornthwaite on the side of the Sabbatarians, have all displayed their ingenuity and talents on this very important question.

SABELLA, in natural history, a genus of the Vermes Testacea class and order. Generic character: animal a nereis, with a ringent mouth, and two thicker tentacula behind the head; shell tubular, composed of particles of sand, broken shells and vegetable substances, united to a membrane by a glutinous cement. There are twenty-five species; of which we may notice S. scruposa; shell solitary, loose, simple, curved, with lentiform glossy granulations. It inhabits India and the American islands. The

shell is subulate, obtuse at the tip, as thick as a swan's quill, and composed of equal white grains of sand. S. alveolata, has numerous parallel tubes communicating by an aperture, forming in the mass the appearance of honey-combs. This is described by Ellis and Pennant. It is found on European coasts, covering the rocks for a considerable space, and easily breaking under the feet. The shell is composed chiefly of sand, and very fine fragments of shells; the tubes straightish, two or three inches long.

SABLE. See MUSTELA.

SABLE, in heraldry, denotes the colour black, in coats of arms belonging to gentlemen; but in those of noblemen it is called diamond; and in those of sovereign princes, saturn. It is expressed in engraving by perpendicular and horizontal hatches crossing one another.

SABRE, a kind of sword, or scimetar, with a very broad and heavy blade, thick at the back, and a little falcated, or crooked towards the point. It is generally worn by the heavy cavalry and dragoons. The grenadiers, belonging to the whole of the French infantry, are likewise armed with sabres. The blade is not so long as that of a small sword, but it is nearly twice as broad. French hussars wear the curved ones somewhat longer than those of the grenadiers. Perhaps it may be in the contemplation of his Royal Highness the Commander in Chief, to arm the British grenadiers with this useful and formidable weapon.

SACCHARUM, in botany, *sugar-cane*, a genus of the Triandria Digynia class and order. Natural order of Gramina, Gramineæ, or Grasses. Essential character: calyx two-valved, involucred with a long lanugo; corolla two-valved. There are eleven species; among which we shall notice the S. officinarum, common sugar-cane, the root of this plant is jointed, like that of other sorts of cane, or reed; from this root arises four, five, or more shoots, proportionable to the age or strength of the root, eight or ten feet high according to the goodness of the ground; in very good rich soils, canes have been measured nearly twenty feet in height, these are not so much esteemed as those of a middling growth, abounding in juice, and having little of the essential salt.

The canes are jointed, more or less distant according to the soil; a leaf is found at each joint, the base of which embraces the stalk to the next joint above its insertion, before it expands; from hence to the point it is three or four feet in length, on the under side is a deep whitish furrow, or hollowed midrib, broad and prominent; the edges are thin, and armed with small sharp teeth, which are scarcely to be discerned with the naked eye; the flowers are produced in panicles, at the top of the stalks, from two to three feet long, composed of many spikes, nine or ten inches in length; these are again subdivided into smaller spikes, having a long down inclosing the flowers, so as to hide them from sight; the seed is oblong, pointed, and ripens in the valves of the flower. It has been asserted that the sugar-cane is not indigenous of America; but that it migrated through the Europeans from Sicily and Spain to Madeira and the Canary islands, afterwards to the West Indian islands, to Mexico, Peru, and Brazil.

SACCOLATES, in chemistry, salts formed from the SACLACTIC *acid*, which see.

SACERDOTAL, something belonging to priests.

SACK *of wool*, a quantity of wool containing just twenty-two stone, and every stone fourteen pounds. In Scotland, a sack is twenty-four stone, each stone containing sixteen pounds.

SACKS *of earth*, in fortification, are canvas-bags filled with earth. They are used in making intrenchments in haste, to place on parapets, or the head of the breaches, &c. to repair them, when beaten down.

SACKBUT, a musical instrument of the wind kind, being a sort of trumpet, though different from the common trumpet both in form and size: it is fit to play a bass, and is contrived to be drawn out, or shortened, according to the tone required, whether grave or acute.

SACLACTIC *acid*. To this acid Fourcroy has given the name of mucous acid, because it is obtained from gum arabic and other mucilaginous substances. This acid may be obtained by the following process: To one part of gum-arabic, or other mucilaginous substance, add two parts of nitric acid in a retort, and apply a gentle heat. There is at first disengaged a little nitrous gas and carbonic acid gas, after which let the mixture cool. There is then precipitated a white powder which is slightly acid. This powder is the saclactic acid. Thus obtained, saclactic acid is a little gritty, and with a weak acid taste. It is readily decomposed by heat, and yields an acid liquor which

crystallizes by rest in the shape of needles. It is partly sublimed in needles, or brown plates, with an odour similar to that of benzoic acid. Saclactic acid, in the state of powder, is not very soluble in water. Cold water does not take up more than 200 or 300 parts of its weight, boiling water does not take up above one half more. On cooling, the acid is deposited in brilliant scales, which become white in the air. The solution has an acid taste. It reddens the tincture of turnsole. Its specific gravity at the temperature of 50° is nearly the same as that of water. This acid enters into combination with earths, alkalies, and metallic oxides, and the salts which it forms are known by the name of saccolates.

SACRAMENT, signifies, in general, a sign of a thing sacred and holy, and is defined to be an outward and visible sign of a spiritual grace. Thus there are two objects in a sacrament, the one the object of the senses, and the other the object of faith. Protestants admit only of two sacraments, baptism and the eucharist, or Lord's supper: but the Roman Catholics own seven, viz. baptism, confirmation, the eucharist, penance, extreme unction, ordination, and marriage.

SACRIFICE, a solemn act of religious worship, which consisted in dedicating or offering up something animate or inanimate on an altar, by the hands of the priest, either as an expression of gratitude to the deity for some signal mercy, or to acknowledge a dependance on him, or to conciliate his favour.

SACRILEGE, is church robbery, or a taking of things out of an holy place, as where a person steals any vessels, ornaments, or goods of the church.

SADDLE, is a seat upon a horse's back, contrived for the conveniency of the rider. The ancient Romans are supposed not to have made use of saddles and stirrups, and it is thought that they did not come into use till the time of Constantine the Great, A. D. 340, as appears from the Greek historian, Zonaras, who (through his whole history) makes no mention of a saddle for a horse, before such time as Constans, attempting to deprive his brother Constantine of the empire, made head against his army, and entering into the squadron where he himself was, cast him beside the saddle of his horse.

SAFE *conduct*, in law, is a security given by the King, under the Great Seal, to a stranger, for his safe coming into, and passing out of the realm. Passports, however, under the King's sign manual, or licences from his ambassadors abroad, which are now more usual, are obtained with greater facility.

SAFFRON. See CROCUS.

Saffron is cultivated in fields for use, and is no where raised with so much success as in England, the English saffron being generally allowed to be greatly superior to any other. The usual way of propagating it is by the bulbs, of which it annually produces new ones. These are planted out in trenches at five inches distance, or less, and they seldom fail. They produce only leaves the first year, but in September, or October, of the year following, they flower. The saffron is gathered as soon as the flowers open, and is then separated from all filth, and formed into cakes by a very careful pressure and gentle heat. At the end of October, when the flowering season is over, the bulbs are taken out of the ground and hung up in a dry place, and in spring are put into the ground again.

It is not, however, the entire flower of the plant that produces it, but only some of its internal parts. It is met with in the shops in flat and thin cakes, into which it has been formed by pressing, and which consist of many long and narrow filaments, that are smallest in their lower part, where they are of a pale yellow colour, in their upper part they are broader and indented at their edges, and of a very strong and deep orange colour, approaching to redness. They are somewhat tough, moderately heavy, very easily cut, of an acrid, penetrating, but not unpleasant smell, somewhat affecting the head, and of a bitterish and hot, but highly cordial taste. Thrown into water, they almost instantaneously give it a strong yellow or reddish colour, according to the quantity used. These filaments are the cristated capillaments, into which the pistil of the flower divides at its head; they are of a deep reddish orange colour, while growing, and there are only three of them in each flower.

Hitherto saffron has not been subjected to a correct chemical analysis. From the experiments of Neumann, it does not appear that any volatile oil can be procured from it by distillation. It is probable, however, that it owes its strong smell to such a principle, though in too small a quantity to be easily obtained separate. The colouring

matter of saffron is equally soluble in alcohol and water.

SAGAPENUM. See GUM *resin*.

SAGE. See SALVIA.

SAGINA, in botany, *pearl-wort*, a genus of the Tetrandria Tetragynia class and order. Natural order of Caryophyllei, or Caryophylleæ. Essential character: calyx four-leaved; petals four; capsule one-celled, four-valved, many-seeded. There are five species, of which the most remarkable is the sagittafolia, growing naturally in many parts of England. The root is composed of many strong fibres, which strike into the mud; the footstalks of the leaves are in length proportionable to the depth of the water in which they grow; so they are sometimes almost a yard long: they are thick and fungous; the leaves, which float upon the water, are shaped like the point of an arrow, the two ears at their base spreading wide asunder, and are very sharp pointed. There is always a bulb at the lower part of the root, growing in the solid earth beneath the mud. This bulb constitutes a considerable part of the food of the Chinese; and upon that account they cultivate it. Horses, goats and swine eat it; cows are not fond of it.

SAGITTA, in astronomy, the *arrow*, or *dart*, a constellation of the northern hemisphere, near the eagle, consisting of five stars, according to Ptolemy and Tycho; but in Mr. Flamsteed's catalogue, of no less than twenty-three.

SAGITTA, in geometry, a term used for the absciss of a curve.

SAGITTA, in trigonometry, the same with the versed sine of an arch.

SAGITTARIA, in botany, *arrow-head*, a genus of the Monoecia Polyandria class and order. Natural order of Tripetaloideæ. Junci, Jussieu. Essential character: calyx three-leaved; corolla three-petalled; male, filaments commonly twenty-four: female, pistils many; seeds many, naked. There are five species.

SAGITTARIUS, the *archer*, in astronomy, the ninth sign of the zodiac. The stars in this constellation in Ptolemy's catalogue are thirty-two, in Tycho's sixteen, and in Mr. Flamsteed's fifty-two.

SAGO, a simple brought from the East Indies, of considerable use in diet as a restorative.

Sago and salop are vegetable fecula. The former is the produce of the cycas circinalis, and is extracted from the pith of the stem and branches, by maceration in water; it is washed, passed through a perforated copper plate, so as to reduce it to grains, which are dried. Salop is the produce of the orchis mascula. The lately introduced arrow-root powder is said to be the produce of the maranta arundinacea. Cassava is prepared from the tuberose root of the manise (jatropha manihot). With the fecula of this root, there is associated an acrid and poisonous juice, which is, however, completely separated by washing, in the process by which it is extracted. The roots of the bryonia alba, and the arum maculatum, are likewise composed principally of fecula, associated with acrid matter, which is separated in the process by which the fecula is extracted from them. These two were formerly prepared for medicinal use. Wheat affords, perhaps, a larger quantity of fecula than any other vegetable substance, and in a state of perfect purity. A very pure fecula, in large quantity, is also extracted from the potatoe, the root being peeled, well cleansed, and rasped, the pulp placed on a hair sieve, and water poured on it until the fecula is extracted, which, after being deposited, is washed and dried.

SAHLITE, in mineralogy, a species of the Talc genus, of a light greenish-grey colour; it occurs massive; externally it is shining and splendent; its principal fracture is foliated; fragments frequently rhomboidal; consists of very coarse granular distinct concretions: it is translucent on the edge; semihard, brittle, and easily frangible; specific gravity 3.21. It is found at Sahlberg in Sweden.

SAICK, or SAIQUE, a Turkish vessel, very common in the Levant for carrying of merchandize.

SAIL, in navigation, an assemblage of several breadths of canvass, sewed together by the lists, and edged round with a cord, fastened to the yards of a ship, to make it drive before the wind. Every yard in a ship has its proper sail, except the cross-jack, which takes its name from the yard: and those which are not bent to the yard, are the flying jib, fore, foretop, main, maintop, maintop-gallant, mizen, mizentop-mast, stay-sails, main and maintop studding sails.

SAILING, properly denotes the art of navigating and working a ship, or of causing her to observe such motions and directions as are assigned by the navigator; in which sense, sailing differs from navigation, and must be learned by practice on shipboard. See NAVIGATION.

Sailing also denotes a particular method of navigation; in which sense we say, Mercator's sailing, plane sailing, parallel sailing, middle latitude sailing, and great circle sailing.

Sailing, *great circle*, in navigation, the art of finding what places a ship must go through, and what courses to steer; so that her tract shall be in the arch of a great circle, or nearly so, passing through the place sailed from and that bound to. It is chiefly on account of the shortest distance, that this method of sailing has been proposed; for in the sphere, it is well known that the shortest distance between two places is the arch of a great circle intercepted between them, and not in the rhumb or spiral passing through those places.

As, in Mercator's sailing, the several cases are solved by plane triangles; so the solution of the cases of great circle-sailing is obtained by means of spherical triangles: and, therefore, the navigator should be master of spherical trigonometry, before he attempts this method. See Trigonometry.

SAILORS, the principal seamen who are employed in working or managing the sails, the tackle, steering, &c.

SAL *ammoniac, natural*, in mineralogy, a species of the fossil salts, is of a greyish white colour, passing to yellow. It is flaky, and of a saline consistence. It occurs massive, and likewise crystallized: the crystals are small and adhere or intersect one another; externally shining, internally splendent or shining, and lustre vitreous. The substance is composed of

Muriate of ammonia ...	97.50
Sulphate of ammonia ..	2.50
	100.00

When placed on burning coals it emits a peculiar odour, and is volatilized in the form of white smoke; when burned or rubbed with lime, it emits an ammoniacal smell. It is said to be the product of volcanoes, and pseudo-volcanoes, where it occurs in different forms; it is also found in the waters of different lakes in Tuscany; it is found at Vesuvius, Etna, and the Lipari Æolian islands; in France; at Mount Hecla, in Iceland; and in the vicinity of inflamed beds of coal in Scotland and England. It is also found in divers parts of Asia, and in the Isle of Bourbon.

SALACIA, in botany, a genus of the Gynandria Triandria class and order. Essential character: monogynous, or one-styled; calyx five-parted; corolla five-petalled; anthers placed on the apex of the germ. There are two species, *viz.* S. chinensis, and S. cochinchinensis.

SALE *of goods*. If a man agrees for the purchase of goods, he shall pay for them, before he carries them away, unless some term of credit is expressly agreed upon.

If a man upon the sale of goods, warrants them to be good, the law annexes to this contract a tacit warranty, that if they be not so, he shall make compensation to the purchaser; such warranty, however, must be on the sale. But if the vender knew the goods to be unsound, and has used any art to disguise them, or if in any respect, they differ from what he represents them to be to the purchaser, he will be answerable for their goodness, though no general warranty will extend to those defects that are obvious to the senses.

If two persons come to a warehouse, and one buys, and the other to procure him credit, promises the seller, "if he do not pay you, I will;" this is a collateral undertaking, and void without writing, by the statutes of frauds; but if he say, let him have the goods, I will be your paymaster, this is an absolute undertaking as for himself, and he shall be intended to be the real buyer, and the other to act only as his servant. The question in these cases is always which party was originally trusted. For if the party to whom the goods are delivered was ever considered as responsible, the engagement of the other is void, unless it is in writing; after earnest is given, the vender cannot sell the goods to another without a default in the vender, and therefore, if the vendee does not come and pay, and take the goods, the vender ought to give him notice for that purpose; and then if he does not come and pay, and take away the goods in convenient time, the agreement is dissolved, and he is at liberty to sell them to any other person.

SALEP, or Salop. See Sago.

SALIANT, in fortification, denotes projecting. There are two kinds of angles, the one saliant, which are those that present their point outwards; the other reentering, which have their points inwards. Instances of both kinds we have in tenailles and star-works.

Saliant, Salient, or Saillant, in heraldry, is applied to a lion, or other beast, when its fore-legs are raised in a leaping posture. A lion salient is that which is

erected bend-ways, standing so as that his right fore-foot is the dexter chief point, and his hinder left foot is the sinister base point of the escutcheon, by which it is distinguished from rampant.

SALIC, or SALIQUE LAW, an ancient and fundamental law of the kingdom of France, usually supposed to have been made by Pharamond, or at least by Clovis, in virtue whereof males are only to inherit.

SALICORNIA in botany, *jointed glasswort*, a genus of the Monandria Monogynia class and order. Natural order of Holoraceæ. Atriplices, Jussieu. Essential character: calyx, ventricose, entire; petals none; stamens one or two; seed one covered by the calyx. There are nine species, of which the most remarkable is the S. perennis, with a shrubby branching stalk, which grows naturally in Sheppey island. They are perennial, and produce their flowers in the same manner as the former. The inhabitants near the sea-coasts where these plants grow, cut them up toward the latter end of summer, when they are fully grown: and after having dried them in the sun, they burn them for their ashes, which are used in making of glass and soap. These herbs are by the country people called kelp, and promiscuously gathered for use.

SALISBURIA, in botany, so named in honour of Richard Anthony Salisbury, a genus of the Monoecia Polyandria class and order. Essential character: male, amentaceous; anthers incumbent, deltoid: female, solitary; calyx four-cleft; drupe with a triangular shell. There is only one species, viz. S. adiantifolia.

SALIVA. The saliva which is secreted by peculiar glands, and which flows into the mouth, is a clear viscid fluid, without taste or smell. It has generally a frothy appearance, being mixed with a quantity of air. Saliva has a strong attraction for oxygen, which by trituration it communicates to some metallic substances, as mercury, gold, and silver. When saliva is boiled in water, albumen is precipitated, and when it is slowly evaporated, muriate of soda is obtained. A vegetable gluten remains behind, which burns with the odour of prussic acid. Saliva becomes thick by the action of acids. Oxalic acid precipitates lime. Saliva is also inspissated by alcohol. It is decomposed by the alkalies; and the nitrates of lead, of mercury, and the silver, precipitate muriatic and phosphoric acids. By distillation in a retort, it froths up, affords nearly four-fifths of its quantity of water almost pure, a little carbonate of ammonia, some oil, and an acid. What remains behind consists of muriate of soda, phosphate of soda and of lime.

SALIX, in botany, *willow*, a genus of the Dioecia Diandria class and order. Natural order of Amentaceæ. Essential character: calyx ament, composed of scales; corolla none: male, nectary a melliferous gland: female, style bifid; capsule one celled, two valved; seeds downy. There are fifty-three species; of which we may notice the following: the S. caprea, or common sallow-tree, grows to but a moderate height, having smooth, dark-green, brittle branches; oval, waved, rough leaves, indented at top, and woolly underneath. It grows abundantly in this country, but more frequently in dry than moist situations. It is of a brittle nature, and unfit for the basket-makers; but will serve for poles, stakes, and to lop for fire-wood: and its timber is good for many purposes. The S. alba, white, or silver-leaved willow, grows to a great height and considerable bulk, having smooth, pale-green shoots; long, spear-shaped, acuminated, sawed, silvery-white leaves, being downy on both sides, with glands below the serratus. This is the common white willow, which grows abundantly about towns and villages, and by the sides of rivers and brooks, &c. S. fragiles, fragile or crack willow, rises to a middling stature, with brownish, very fragile, or brittle branches; long, oval, lanceolate, sawed, smooth leaves of a shining green on both sides, having dentated glandular foot-stalks. This sort in particular being exceedingly fragile, so that it easily cracks and breaks, is unfit for culture in osier-grounds. S. Babylonica, Babylonian pendulous Salix, commonly called weeping willow, grows to a largish size, having numerous, long, slender, pendulous branches, hanging down loosely all round in a curious manner, and long; narrow, spear-shaped, serrated, smooth leaves. This curious willow is a native of the East.

All the species of Salix are of the tree kind, very hardy, remarkably fast growers, and several of them attaining a considerable stature when permitted to run up to standards. They are usually of the aquatic tribe, being generally the most abundant, and of most prosperous growth, in watery situations; they, however, will grow freely almost any where, in any common soil and exposure; but considerably the fastest and strongest in low moist land,

particularly in marshy situations, by the verges of rivers, brooks, and other waters; likewise along the sides of ditches, &c. which places often lying waste, may be employed to good advantage in plantations of willows for different purposes.

SALLY, in the military art, the issuing out of the besieged, from their town or fort, and falling upon the besiegers in their works, in order to cut them off, nail their cannon, hinder the progress of their approaches, destroy their works, &c.

SALMASIA, in botany, so named in memory of Claudius Salmasius, a genus of the Pentandria Trigynia class and order. Natural order of Cisti, Jussieu. Essential character: calyx, five parted; corolla, five petalled; style none; capsule, three celled, three valved, many seeded. There is but one species, viz. S. racemosa, a native of the woods of Guiana.

SALMO, the *salmon*, in natural history, a genus of fishes of the order Abdominales. Generic character: head smooth, compressed; tongue white and cartilaginous; teeth in the jaws and on the tongue; gill-membrane from four to twelve-rayed; body furnished at the hind part with an adipose fin. Gmelin enumerates fifty five species, and Shaw sixty-two, of which we shall notice the following:

S. salar, or the common salmon. This abounds principally in the Northern Seas, which it quits at particular periods, to ascend rivers to a very considerable height, and deposit its spawn in them. In order to gain the favourite spots in rivers for this purpose, which are sometimes at the distance of several hundred miles from the ocean, these fishes will overcome difficulties of surprising extent, stemming the most rushing currents, and leaping with astonishing activity over various elevations. It is related, that the same individual fishes will return to the same spot for a succession of seasons; in this respect exhibiting preferences similar to those of birds in similar circumstances. The salmon is generally about two feet and three-quarters long, and has been seen of the length of six, and weighing, in this case, seventy-four pounds. This fish is remarkable for the excellence of its flavour, and its richness, and is a welcome dish at every table. It constitutes, also, an important article of commerce. The principal fishery for salmon, in this island, is at Berwick on the Tweed. In November, they begin to ascend that river, and soon afterwards deposit their spawn with extreme care, in recesses in the sands. Here it remains till the advance of spring, when the young are completely developed, and grow with such rapidity, that, by the beginning of August, they attain to the weight of six or seven pounds, and occasionally even more. Some hundreds have been occasionally taken in a single draught; but the average number is not above fifty. These fishes, in their most abundant season, are salted and barrelled for exportation. The principal part of these, taken before April, is sent to the London market, in a fresh state, and packed in ice. In July, the most plentiful month in the year, salmon have been sold at Berwick, at the rate of less than a halfpenny per pound. The rent of the forty principal salmon-fisheries on the Tweed, between its mouth and fourteen miles upwards, towards its source, amounted, many years since, to between five and six thousand pounds per annum, and the number of fishes annually taken by these, is calculated at upwards of two hundred thousand. It is a singular circumstance, that no food, if we may believe the uniform statements of fishermen, is ever found in the stomach of the salmon; yet fishes and worms are employed by the angler with success in taking them. The case may possibly be, that, at particular seasons, they may totally neglect food, as is the case with some other species of animals, particularly seals, which abstain for a series of months, and this instance of exception may have been exaggerated into a universal practice.

S. fario, or common trout, is found in almost all the European streams, at least such as are cool and clear. Its length, in general, is about fourteen inches. Occasionally, it has been known to weigh ten pounds. Trout of the common size, however, are far preferable to those of such extraordinary magnitude. These fishes subsist on worms, small fishes, shell-fish, and water-insects. They are extremely rapacious and devouring, and not unfrequently prey upon each other. Those are most esteemed which are found in the coldest streams, and they are generally regarded as an elegant and luxurious article of food. They appear to have been only slightly known to the Greeks and Romans, and to have been rather admired for the beauty of their appearance, than eagerly sought after for the table.

S. salvelinus, or red charr, is about a foot long, very similar in form to the common

salmon, but more slender. It abounds in the rivers of Siberia, and the lakes of Germany, and in this country, in the lakes of Cumberland and Westmoreland. It is considered as one of the highest delicacies, and has the most brilliant colours, and finest flavour, when inhabiting the coldest waters.

The S. eperlanus, or smelt, is about seven inches long, highly elegant, of a tapering form, and semi-transparent appearance. It has an odour not unlike that proceeding from vegetables, and which has by some been resembled to that of a violet, and by others to that of a cucumber. In the winter months it is caught in extreme abundance in the rivers Thames and Dee.

The S. Greenlandicus, or Greenland salmon. These abound off the coast of Greenland, where they are taken in vast quantities and dried, not only for the use of man, but of cattle, for which they constitute a valuable food in winter. It is about the size of a smelt.

S. thymallus, or the grayling, is about a foot and a half long, and abounds in the rivers of mountainous countries in Europe and Asia. It resembles the trout in form. In some of the rivers of England, it is found in great perfection. It feeds on insects and fishes, and is highly voracious, catches with extreme avidity at the bait, and swims with extraordinary rapidity, passing through the water like a dart, or a meteor through the air.

SALON, or SALOON, in architecture, a very lofty spacious hall, vaulted at top, and sometimes comprehending two stories or ranges of windows. The salon is a grand room in the middle of a building, or at the head of a gallery, &c. Its faces or sides ought all to have a symmetry with each other; and as it usually takes up the height of two stories, its ceiling, should be with a moderate sweep. Salons are frequently built square, and sometimes octagonal.

SALPA, in natural history, a genus of the Vermes Mollusca class and order: body loose, nayant, gelatinous, tubular, and open at each extremity: intestine placed obliquely: eleven species have been enumerated, in two divisions; A furnished with an appendage: B. without the terminal appendage. The animals of this genus are of a gregarious nature and often adhere together: they swim with great facility, and have the power of contracting or opening at pleasure the cavities at the extremities.

SALSOLA, in botany, *salt-wort*, a genus of the Pentandria Digynia class and order. Natural order of Holoraceæ. Atriplices, Jussieu. Essential character: calyx, five-leaved, corolla none; capsule one-seeded; seed screw-shaped. There are thirty-one species. These plants are well known for producing alkaline salt, commonly called barilla, soda, or kelp; many of them are herbaceous and annual, some have shrubby stems. The leaves are generally alternate, in some opposite, others round or flat; flowers terminating or axillary. S. kali grows naturally in the salt marshes in divers parts of England. It is an annual plant, which rises above five or six inches high, sending out many side branches, which spread on every side, with short awl-shaped leaves, which are fleshy, and terminate in acute spines. S. soda rises with herbaceous stalks near three feet high, spreading wide. The leaves on the principal stalk, and those on the lower part of the branches, are long, slender, and have no spines; those on the upper part of the stalk and branches are slender, short, and crooked. All the sorts of glass-wort are sometimes promiscuously used for making soda or mineral alkali, but this species is esteemed best. The manner of making it is as follows: having dug a trench near the sea, they place laths across it, on which they lay the herbs in heaps, and having made a fire below, the liquor which runs out of the herbs drops to the bottom, which at length thickening, becomes soda, which is partly of a black, and partly of an ash-colour, very sharp and corrosive, and of a saltish taste. This, when thoroughly hardened, becomes like a stone, and in that state is transported to different countries for the making of glass, soap, &c.

SALT, *culinary*, or MURIATE of SODA. This salt is one of the most abundant productions of nature, and exists native in much greater quantity than any other neutral salt. The waters of the ocean owe their saltness to it, it is found in a number of mineral springs, and it forms immense strata in the bowels of the earth, or rising on the surface, even to the height of mountains. According as it is produced from these sources, it is named sea-salt, or rock-salt. Rock-salt is solid, hard, and more or less transparent, of a white, grey, or reddish colour, sometimes of a bright or deep red, or yellow, and more rarely with spots of blue. Its fracture is foliated or fibrous; generally it is massive, but sometimes crystallized in cubes, and its fragments are al-

ways of a cubical form. The colours have been supposed to depend on the oxide or muriate of iron. In general it is pure, and hence its taste is purely saline; but sometimes it is bitter from the presence of foreign salts. There are immense mines of it in different countries. Those of Cracow, in Gallicia, have been long celebrated. It abounds in the east and south of Germany, is found in large quantities in Spain, and likewise in Cheshire, in England. In Africa, Asia, and America, it is not less extensively distributed, forming hills above the surface, or very extensive beds. It is always connected with rocks of secondary formation, and generally with gypsum or sulphate of lime.

Dr. Watson, in the second volume of his "Essays," speaking of the salt mines, says, "There are several mines of rock-salt near Northwich in Cheshire, the first of which was discovered as they were boring for coal in the year 1670. The springs which are met with both above and below the level of the Northwich bed of rock-salt, are strongly impregnated with salt. This is easily accounted for: the rain-water, in sinking through the ground which lies over the rock-salt, at last arrives at the salt; its further descent is in a great measure obstructed by the solid body of salt; it rests upon it, and, in resting upon it, dissolves it, and thus constitutes a brine-spring above the level of the bed of rock-salt. The brine-springs, which are found below that level, probably arise from the water, which has dissolved a portion of rock-salt, in sinking to that depth in the earth. I have," continues the Doctor, "had the curiosity to go to the bottom of some of the most famous mines in England, but I never thought my labour, in these subterraneous expeditions, so well rewarded as in the sight of the rock-salt mines at Northwich. These are superior to the mines at Cracow, in Poland, which have, for many centuries, been the subject of general admiration." A single pit, at Northwich, yields, at a medium, 4,000 tons of salt in a year.

In different countries, the process of obtaining salt is different. In very cold climates, the water being received into shallow ditches during the winter, is frozen, by which a great part of the superfluous water is removed, and the remaining liquor affords salt, by artificial evaporation. In warm climates, it is obtained by spontaneous evaporation. The water is received into broad, shallow trenches at the sea-side, without the reach of the tide. The bottom of these is made of clay, well beaten, and they are divided into several departments. The fluid being thus spread out on an extensive surface, quickly evaporates, and by sluices it is removed from one department to another, so that when it arrives at the last, it is a strong brine, and the salt is soon deposited. It is necessarily mixed with the clay of the ground, and with several of the neutral salts, and other impurities, which sea-water contains. Salt, prepared in this manner, is known by the name of bay-salt. In colder climates, recourse must be had to artificial evaporation. The water is heated in shallow iron pans. Muriate of soda possesses the singular property, that it is as soluble in cold as in hot water; after due evaporation, therefore, it begins to crystallize on the surface of the hot liquor; the crystals, as they increase, fall to the bottom of the vessel, are raked out, and set to drain. This is the process by which it is obtained in this country. Sometimes this method is conjoined with natural evaporation. The sea-water, before it is received into the boiler, is pumped into a large reservoir, under which faggots of thorns, &c. are suspended. It is allowed to drop over these, and a large surface being thus presented to the atmosphere, while the air is also rapidly renewed, a considerably part of the water is evaporated. It is then conveyed to the boiler, and evaporated in the usual manner. Or, in some of the northern departments of France, the sea-water is made to flow over a bottom of clay covered with sand, which favours both the evaporation of the water, and the concretion of the salt; the saline deposit, which is at length formed, is lixiviated with sea-water, which, becoming thus more impregnated with salt, is concentrated by boiling, so as to afford it by hasty crystallization. Sea-salt, obtained by any of these processes, is never perfectly pure. Sea-water, by its analysis, is found to contain, besides muriate of soda, several other neutral salts, particularly muriate of magnesia, muriate of lime, and sulphate of soda. These being much more soluble in hot, than in cold water, remain dissolved in the hot liquor, from which the salt crystallizes. A small quantity of them, however, still adheres to the muriate of soda, they render it deliquescent, give it a bitter taste, and considerably impair its antiseptic power. Different processes have therefore been contrived to obtain the salt free from these mixtures. The

most simple is merely to procure the salt by a slow artificial evaporation. It then crystallizes with scarcely any mixture of the others. This is the cause of the superior purity of the bay-salt. Hence, also, the larger the crystals of sea-salt are, they may be justly supposed to be the purer, as the largeness of the crystals is owing to the slowness of the evaporation by which they are formed.

For chemical purposes, muriate of soda is most easily purified, by dissolving it in water, and adding to its solution a solution of carbonate of soda, drop by drop, till no cloudiness is produced by the addition. Every foreign salt is thus decomposed and precipitated, and the strained solution will contain the pure muriate of soda, which may be crystallized. Muriate of soda has a salt, rather agreeable taste, being, when pure, free from all bitterness; it is soluble in rather less than three parts of water, at the temperature of 60°. The crystals neither deliquesce, nor effloresce, on exposure to the air; the common sea-salt, indeed, is deliquescent; but this is owing to the muriates of magnesia and lime, which adhere to it. Exposed to heat, the crystals of muriate of soda decrepitate from the sudden conversion of their water of crystallization into vapour. If the temperature is raised to a red heat, the salt melts; in an intense heat, it is volatilized in white vapours, without having undergone any decomposition.

Crystallized muriate of soda contains 53 of soda, and 47 of acid, containing, however, some water of composition, so that of real acid, the quantity is 38.83. Its specific gravity is 2.12. This salt is decomposed by the sulphuric and nitric acids, in the same manner as the muriate of potash is. It is from its decomposition by the sulphuric acid, that the muriatic acid is best obtained, as has already been observed. When decomposed by the nitric acid, part of the latter is decomposed, a quantity of its oxygen being transferred to the muriatic. One of the most important practical problems in chemistry is to decompose this salt, so as to obtain its alkali. It abounds so much in nature, that if such a process, capable of being carried on to advantage, could be discovered, a vast supply of soda would be obtained; and as this alkali can be employed for every purpose that potash can, and is even much superior to it for some uses, such a discovery would be of much importance to the chemical arts. Salt is decomposed in the usual mode by sulphuric acid; and to defray the expense, the muriatic acid is collected and employed in the manufacture of sal ammoniac, in the preparation of oxymuriatic acid for bleaching, or for any other useful purpose to which it can be applied. The sulphate of soda is calcined in a reverberatory furnace, to free it from any superfluous acid. It is then to be decomposed. It is of very extensive use. Its application to preserve animal substances from putrefaction is well known; the theory of its antiseptic quality has never yet been properly explained. It is also taken universally as a seasoning to food, and seems to be very necessary to promote digestion, as even the lower animals, it has been proved, languish when altogether deprived of it. It is employed in a variety of arts. In the manufacture of pottery of the coarser kind, when it is thrown into the oven in which the ware is baked, it is converted into vapour, and, being applied in this state to the surface of the vessels, glazes them, an effect probably owing to the combination of its alkali with the siliceous earth of the pottery. It is employed in the manufacture of glass, which it is said to render whiter and clearer; in that of soap, which it makes harder; as a flux, in the melting of metals from their ores; and in a variety of chemical and pharmaceutical processes.

Salt, in a chemical sense, is a chrystallizable substance, considerably soluble in water, and highly sapid. The term is applied likewise by modern chemists to all the crystallizable acids, or alkalies, or earths, or combinations of acids with alkalies, earths, or metallic oxides: hence salts in chemistry are distinguished into alkaline, earthy, and metallic, and they take their names from the acid, and alkali, &c. of which they are combined: thus the *sulphate* of soda is a combination of *sulphuric* acid and soda; the *sulphite* of soda is a combination of *sulphurous* acid and soda. The termination *ate* denotes that the salt is formed of the acid containing the greater quantity of oxygen, and the termination *ite* of the acid, containing the smaller quantity of oxygen. There are also salts of triple combinations, as alum, tartarized antimony, &c. Salts are either also neutral, that is where the ingredients are in perfect saturation, (see Neutralization,) or with the acid in excess, of which tartar is an example, or with an excess of the base, as in borax. These circumstances have been distinguished by the prefix *super* in the first case, and *sub* in the latter: hence tartar is

named the super-tartrite of potash; and borax, the sub-borate of soda.

SALVADORA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Atriplices, Jussieu. Essential character: calyx four-cleft; corolla four-cleft; berry one-seeded; seed covered with an aril. There are three species found in China.

SALVAGE *money*, a reward allowed by the civil and statute law, for the saving of ships or goods from the danger of the seas, pirates, or enemies. Where any ship is in danger of being stranded, or driven on shore, justices of the peace are to command the constables to assemble as many persons as are necessary to preserve it; and on its being preserved by their means, the persons assisting therein shall, in thirty days after be paid a reasonable reward for the salvage, otherwise the ship or goods shall remain in the custody of the officers of the customs, as a security for the same.

SALVIA, in botany, *sage*, a genus of the Diandria Monogynia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: corolla unequal; filaments fastened transversely to a pedicle. There are seventy-nine species. This extensive genus consists of herbs or under shrubs; the flowers are from one to three together from a bracte, or a leaf, frequently in spikes. S. officinalis, or common large sage, which is cultivated in gardens, of which there are the following varieties: 1. The common green sage. 2. The wormwood sage. 3. The green sage with a variegated leaf. 4. The red sage. 5. The red sage with a variegated leaf. These are accidental variations, and therefore are not enumerated as species. The common sage grows naturally in the southern parts of Europe, but is here cultivated in gardens for use; but the variety with red or blackish leaves is the most common in the British gardens; and the wormwood sage is in greater plenty here than the common green-leaved sage, which is but in few gardens. S. auriculata, common sage of virtue, which is also well known in the gardens and markets. The leaves of this are narrower than those of the common sort; they are hoary, and some of them are indented on their edges towards the base, which indentures have the appearance of ears.

SALVINIA, in botany, a genus of the Cryptogamia Miscellaneæ class and order. Generic character: male, flowers four to nine, among whorled roots, heaped into a little ball; calyx sub-globular, pubescent, one-celled, consisting of a double membrane; corolla none, unless it be the inner membrane of the calyx; stamen an upright pillar, placed on the base of the calyx: female, in the middle of the ball, solitary; calyx and corolla as in the males; pistils; germs about fifteen, obliquely ovate, blunt, rugged with dots, each on distinct pedicles, fastened to the bottom of the calyx; style none; stigma a dot on the top of the germ; pericarpium none; seeds as many as there are germs, and of the same form. The male and female flowers may be distinguished in the dry plant before the calyxes open, by the size of the protuberant grains.

SALUTATION, the act of saluting, greeting, or paying respect and reverence to any one. There is a great variety in the forms of salutation. The orientals salute by uncovering their feet, laying their hands on their breasts, &c. In England, we salute by uncovering the head, bending the body, &c. The pope formerly paid reverence to none except the emperor, to whom he stooped a very little, when he permitted him to kiss his lips. A prince, or person of extraordinary quality, is saluted at his entering a garrison by the firing of the cannon round the place. In the field, when a regiment is to be reviewed by a king, or his general, the drums beat as he approaches, and the officers salute him one after another, as he passes by, stepping back with the right foot and hand, bowing their half pikes to the ground, and then recovering them gently, bringing up the foot and hand, and planting them; which done, they pull off their hats without bowing. The ensigns salute all together, bringing down their colours near the ground directly before them at one motion, and having taken them up again, gently lift their hats. At sea, they salute by a discharge of cannon, which is greater or less, according to the degree of respect they would show; and here ships always salute with an odd number of guns, and galleys with an even one. To salute with muskets is to fire one, two, or three vollies; which is a method of salutation that sometimes precedes that of cannon, and is chiefly used on occasion of feasts. After the cannon, they also sometimes salute or hail with the voice, by a joint shout of all the ship's company, repeated three times; which salutation also occasionally obtains where they carry no guns, or do not care to discharge any. Saluting with the flag is performed two ways,

either by holding it close to the staff so as it cannot flutter, or by striking it so as it cannot be seen at all, which is the most respectful. Saluting with the sails is performed by hovering the topsails half-way of the masts. Only those vessels that carry no guns salute with the sails.

The following regulations on this subject are deserving of notice: "When any of his Majesty's ships shall meet with any ship or ships belonging to any foreign prince or state, within his Majesty's seas, (which extend to Cape Finisterre) it is expected that the said foreign ships do strike their topsail, and take in their flag, in acknowledgment of his Majesty's sovereignty in those seas: and if any shall refuse, or offer to resist, it is enjoined to all flag-officers and commanders to use their utmost endeavours to compel them thereto, and not suffer any dishonour to be done to his Majesty. And if any of his Majesty's subjects shall so much forget their duty, as to omit striking their top-sail in passing by his Majesty's ships, the name of the ship and master, and from whence, and whither bound, together with affidavits of the facts, are to be sent up to the Secretary of the Admiralty, in order to their being proceeded against in the Admiralty Court. And it is to be observed, that in his Majesty's seas, his Majesty's ships are in nowise to strike to any; and that in no other parts, no ship of his Majesty is to strike her flag or topsail to any foreigner, unless such foreign ship shall have first struck, or at the same time, strike her flag or top sail to his Majesty's ship. The flag-officers and commanders of his Majesty's ships are to be careful to maintain his Majesty's honour upon all occasions, giving protection to his subjects, and endeavouring, what in them lies, to secure and encourage them in their lawful commerce; and they are not to injure, in any manner, the subjects of his Majesty's friends and allies."

SAMARA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Rhamni, Jussieu. Essential character: calyx four-parted; corolla four-petalled; stamina immersed in the base of the petal; drupe one-seeded. There are four species.

SAMBUCUS, in botany, *elder*, a genus of the Pentandria Trigynia class and order. Natural order of Dumosæ. Caprifolia, Jussieu. Essential character: calyx five parted; corolla five-cleft; berry three-seeded. There are five species.

SAMIELS, the Arabian name for a hot suffocating wind peculiar to the desert of Arabia. It blows over the deserts in the months of July and August from the north-west, and sometimes it continues its progress to the very gates of Bagdad, but it is said never to affect any person within the walls. It often passes with the quickness of lightning: and there is no way of avoiding the dire effects but by falling on the ground, and keeping the face close to the earth. Those who are negligent of this caution experience instant death.

SAMOLUS, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Preciæ. Lysimachiæ, Jussieu. Essential character: corolla salver-shaped; stamina fenced by the scalelets of the corolla; capsule one-celled, inferior. There is but one species; viz. S. valerandi, brookweed or water pimpernel; this plant is an inhabitant of every quarter of the globe, in marshes, wet meadows, and ditches; Mr. Miller considers it as an annual; Linnæus marks it as biennial; and others as perennial.

SAMYDA, in botany, a genus of the Decandria Monogynia class and order. Essential character: calyx five-parted, coloured; corolla none; nest bell-shaped, staminiferous; capsules berried within, four-valved, one-celled; seeds nestling. There are nine species.

SAND, in natural history, a genus of fossils, the characters of which are, that they are found in minute concretions; forming together a kind of powder, the genuine particles of which are all of a tendency to one determinate shape, and appear regular, though more or less complete concretions; not to be dissolved or disunited by water, or formed into a coherent mass by means of it, but retaining their figure in it; transparent, vitrifiable by extreme heat, and not dissoluble in, nor effervescing with, acids. See SAND-STONE.

Sand is of great use in the glass manufacture; the white writing sand being employed for making of the white glass, and a coarse greenish-looking sand for the green glass. In agriculture it seems to be the office of sands to make unctuous earths fertile, and fit to support vegetables, &c. For earth alone, we find, is liable to coalesce, and gather into a hard coherent mass, as appears in clay; and being thus embodied, and as it were glued together, is no way disposed to nourish vegetables.

Common sand is a very good addition, by way of manure, to all sorts of clay-lands; it warms them, and makes them more open

and loose. The best sand for the farmer's use is that which is washed by rains from roads or hills, or that which is taken from the beds of rivers; the common sand that is dug in pits never answers nearly so well. However, if mixed with dung, it is much better than laid on alone: and a very fine manure is made by covering the bottom of sheep-folds with several loads of sand every week, which are to be taken away, and laid on cold stiff lands, impregnated as they are with the dung and the urine of the sheep.

Beside clay-land there is another sort of ground very improveable by sand; this is that sort of black boggy land on which bushes and sedge grow naturally, and which they cut into turf, in some places. Six hundred load of sand being laid upon an acre of this land, according to the Cheshire measure, which is near double the statute acre, meliorate it so much, that without ploughing it will yield good crops of oats or tares, though before it would have produced scarcely any thing. If this crop is taken off, the land will be well dunged, and if then laid down for grass, it will yield a large crop of sweet hay.

Once sanding this land will improve it for a vast number of years, and it will yield two crops of hay in the year, if there be weather to make it in. Some land in Cheshire has been, by this means, rendered of twelve times its former value to the owner. The bogs of Ireland, when drained, have been rendered very fruitful land, by mixing sand in this manner among the earth, of which they consist. Add to this, that in all these boggy lands, the burning them, or firing their own turf upon them, is also a great advantage. The common peat, or turf-ashes, mixed with the sand for these purposes, add greatly to its virtue. Sea-sand, which is thrown up in creeks and other places, is by much the richest of all sand for manuring the earth; partly its saltness, and partly the fat and unctuous filth that is mixed among it, give it this great virtue. In the western parts of England, that lie upon the sea coast, they make very great advantages of it. The fragments of sea-shells also, which are always in great abundance in this sand, add to its virtues; and it is always the more esteemed by the farmers, the more of these fragments there are among it.

The sea-sand, used as manure in different parts of the kingdom, is of three kinds: that about Plymouth, and on other of the southern coasts, is of a blue-grey colour, like ashes, which is probably owing to the shells of muscles, and other fish of that or the like colour, being broken and mixed among it in great quantity. Westward, near the Land's End, the sea-sand is very white, and about the isles of Scilly it is very glistening, with small particles of talc; on the coasts of the North Sea, the sand is yellowish, brown, or reddish, and contains so great a quantity of fragments of cockle-shells, that it seems to be chiefly composed of them. That sea sand is accounted best which is of a reddish colour: the next in value to this is the bluish, and the white is the worst of all. Sea-sand is best when taken up from under the water, or from sand-banks, which are covered by every tide. The small grained sand is most sudden in its operation, and is therefore best for the tenant who is only to take three or four crops; but the coarse or large grained sand is much better for the landlord, as the good it does lasts many years.

SAND *bags*, in the art of war, are bags filled with earth or sand, holding each about a cubic foot: their use is to raise parapets in haste, or to repair what is beaten down.

SAND *flood*, a terrible mischief, incident to the lands of Suffolk, and some other parts of England; which are frequently covered with vast quantities of sand, rolling in upon them like a deluge of water, from sandy hills in their neighbourhood.

The flowing of sand, though far from being so tremendous and hurtful as in Arabia, is of very bad consequences in this country, as many valuable pieces of land have thus been entirely lost; of which we give the following instances from Mr. Pennant, together with a probable means of preventing them in future. "I have more than once," says he, "on the eastern coasts of Scotland, observed the calamitous state of several extensive tracts, formerly in a most flourishing condition, at present covered with sands, unstable as those of the deserts of Arabia. The parish of Furvic, in the county of Aberdeen, is now reduced to two farms, and above 500*l.* a year lost to the Errol family, as appears by the oath of the factor in 1600, made before the Court of Session, to ascertain the minister's salary. Not a vestige is to be seen of any buildings, unless a fragment of the church. The estate of Coubin, near Forres, is another melancholy instance. This tract was once worth 300*l.* a year, at this time overwhelmed with sand. This strange inundation was still in motion in 1769, chiefly when a strong

wind prevailed. Its motion is so rapid, that I have been assured, that an apple-tree had been so covered with it in one season, that only the very summit appeared. This distress was brought on about ninety years ago, and was occasioned by the cutting down some trees, and pulling up the bent or star which grew on the sand-hills; which at last gave rise to the act of 15 George II. c. 33, to prohibit the destruction of this useful plant.

"I beg leave to suggest to the public a possible means of putting a stop to these destructive ravages. Providence hath kindly formed this plant to grow only in pure sand. Mankind was left to make, in after times, an application of it suitable to their wants. The sand-hills on a portion of the Flintshire shores, in the parish of Llanasa, are covered with it naturally, and keep firm in their place. The Dutch perhaps owe the existence of part, at least, of their country to the sowing of it on the *mobile solum*, their sand-banks. My humane and amiable friend, the late Benjamin Stillingfleet, Esq. recommended the sowing of this plant on the sandy wilds of Norfolk, that its matted roots might prevent the deluges of sand which that country experiences. It has been already remarked, that wheresoever this plant grows the salutary effects are soon observed to follow. A single plant will fix the sand, and gather it into a hillock; these hillocks, by the increase of vegetation, are formed into larger, till by degrees a barrier is made often against the encroachments of the sea, and might as often prove preventative of the calamity in question. I cannot, therefore, but recommend the trial to the inhabitants of many parts of North Britain. The plant grows in most places near the sea, and is known to the Highlanders by the name of murah; to the English by that of bent-star, mat-grass, or marram. Linnæus calls it arundo arenaria. The Dutch call it helm. This plant hath stiff and sharp-pointed leaves, growing like a rush, a foot and a half long: the roots both creep and penetrate deeply into their sandy beds: the stalk bears an ear five or six inches long, not unlike rye; the seeds are small, brown, and roundish. By good fortune, as old Gerard observes, no cattle will eat or touch this vegetable, allotted for other purposes, subservient to the use of mankind."

Sand *stone*, in mineralogy, is chiefly composed of quartz in rounded grains of various sizes. Sand-stones are stratified, and when disintegrated they form sand. We have many varieties; as, 1. "The calcareous sand-stone," which is of a green or greyish colour: it is moderately hard, and gives sparks when struck against steel. It effervesces with acids: when freed from the calcareous cement there remains a very friable mass of fine white sand. 2. "The ferruginous sand-stone," which is of a reddish brown: it is opaque and soft, and seldom effervesces with acids: it readily disintegrates by exposure to the weather. 3. "Grit-stone," which rarely effervesces with acids, but gives very lively sparks when struck with the steel. It is not easily decomposed by exposure to the air. Sandstone is applied to many important purposes in building; as flag-stones: and the harder kinds of grit-stone are made into grindstones, and on account of their infusibility they are employed for lining furnaces.

SANDARACH. See Resin.

Sandarach, in natural history, a very beautiful native fossil; though too often confounded with the common factitious red arsenic, and with the red matter formed by melting the common yellow orpiment. It is a pure substance, of a very even and regular structure, is throughout of that colour which our dyers term an orange-scarlet, and is considerably transparent even in the thickest pieces. But though with respect to colour it has the advantage of cinnabar while in the mass, it is vastly inferior to it when both are reduced to powder. It is moderately hard, and remarkably heavy; and when exposed to a moderate heat, melts and flows like oil. If set on fire it burns very briskly.

It is found in Saxony and Bohemia, in the copper and silver mines, and is sold to the painters, who find it a very fine and valuable red; but its virtues or qualities in medicine are no more ascertained at this time than those of the yellow orpiment.

SANDORICUM, in botany, a genus of the Decandria Monogynia class and order. Essential character: calyx five-toothed; petals five; nectary cylindrical, truncate, bearing the anthers at its mouth; drupe filled with five nuts. There is only one species, *viz.* S. indicum, a native of the Philippine and Molucca islands.

SANGUINARIA, in botany, a genus of the Polyandria Monogynia class and order. Natural order of Rhoeadeæ. Papaveraceæ, Jussieu. Essential character: calyx two-leaved; corolla eight-petalled; silique ovate,

one-celled. There is only one species, viz. S. canadensis, Canadian sanguinaria, blood-wort, or puccoon a native of the northern parts of America, where it grows plentifully in the woods, and in the spring, before the leaves of the trees come out, the surface of the ground is in many places covered with the flowers, which have some resemblance to our wood anemone, but they have short naked pedicels, each supporting one flower at top. Some of these flowers will have ten or twelve petals, so that they appear to have a double range of leaves, which has occasioned their being termed double flowers, but this is only accidental, the same roots in different years producing different flowers.

SANGUISORBA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Miscellaneæ, Linnæus. Rosaceæ, Jussieu. Essential character: calyx two-leaved, inferior; corolla superior, germ between the calyx and corolla. There are three species with several varieties.

SANICULA, in botany, *sanicle*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ, or Umbelliferæ. Essential character: umbels clustered, subcapitate; fruit rugged; flowers of the disk abortive. There are three species.

SANTALUM, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Onagræ, Jussieu. Essential character: calyx four-toothed, corolla four-petalled, with the petals growing on the calyx, besides four glands; berry inferior, one-seeded. There is only one species, viz. S. album, white and yellow sandal wood. This tree has the appearance of a myrtle, with stiff branchiate branches, jointed, in habit, leaves and inflorescence resembling the privet. It is a native of many parts of India. In the Circar mountains, where it is wild, it is of little value, as it is generally of a small stature. On the Malabar coast it is very large, and the wood of the best kind. The difference of colour constitutes two kinds of sanders, both employed for the same purposes, and having equally a bitter taste, and an aromatic smell. With the powder of this wood a paste is prepared, with which the Chinese, Indians, Persians, Arabians, and Turks, anoint their bodies. It is likewise burnt in their houses, and yields a fragrant and wholesome smell. The greatest quantity of this wood, to which a sharp and attenuating virtue is ascribed, remains in India. The red sanders, though in less estimation, and less generally used, is sent by preference into Europe. This is the produce of a different tree, which is common on the coast of Coromandel. Some travellers confound it with the wood of Caliatour, which is used in dyeing.

The S. album, or white sanders, is brought from the East Indies, in billets about the thickness of a man's leg, of a pale whitish colour. It is that part of the yellow sanders wood which lies next the bark. Great part of it, as met with in the shops, has no smell or taste, nor any sensible quality that can recommend it to the notice of the physician.

The S. flavum, or yellow sanders, is the interior part of the wood of the same tree which furnishes the former, is of a pale yellowish colour, of a pleasant smell, and a bitterish aromatic taste, accompanied with an agreeable kind of pungency. This elegant wood might undoubtedly be applied to valuable medical purposes, though at present very rarely used. Distilled with water, it yields a fragrant essential oil, which thickens in the cold into the consistence of a balsam. Digested in pure spirit, it imparts a rich yellow tincture, which being committed to distillation, the spirit arises without bringing over any thing considerable of the flavour of the sanders. The residuum contains the virtues of six times its weight of the wood.

SANTOLINA, in botany, *lavender-cotton*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx imbricate, hemispherical; down none; receptacle chaffy. There are six species, S. chamæcyparissus, common lavender-cotton, grows naturally in the southern parts of Europe, and is much cultivated in English gardens. All the species are ornamental plants, and may be propagated by planting slips and cuttings in the spring.

SAP. See PLANT.

The sap of trees, chemically considered, is a watery mucilaginous liquid, often strongly saccharine, so as to yield a large quantity of sugar, and to furnish a very strong fermented liquor.

SAP, or SAPP, in the art of war, is the digging deep under the earth of the glacis, in order to open a covered passage into the moat. It is only a deep trench, covered at top with boards, hurdles, earth, sand-bags,

&c. and is usually begun five or six fathoms from the saliant angle of the glacis.

SAPPHIC, in poetry, a kind of verse much used by the Greeks and Latins, denominated from the inventress Sappho. The sapphic verse consists of five feet, whereof the first, fourth, and fifth, are trochees, the second a spondee, and the third a dactyl; as in

1	2	3	4	5
Aure-	*am quis*	*quis medi*	*ocri-*	*tatem*
Dili	*git, tu-*	*tus caret*	*obso-*	*leti*
Sordi	*bus te-*	*cti, caret*	*invi-*	*denda.*

and after every three sapphic verses there is generally subjoined an adonic verse, as

Sobrius aulâ.

SAPINDUS, in botany, *soap-berry-tree*, a genus of the Octandria Trigynia class and order. Natural order of Trihilatæ. Sapindi, Jussieu. Essential character: calyx four-leaved; petals four; capsule fleshy, connate, ventricose. There are thirteen species; of which we shall notice the S. saponaria, with winged leaves, which grows naturally in the islands of the West Indies, where it rises with a woody stalk from 20 to 30 feet high, sending out many branches with winged leaves, composed of several pair of spear-shaped lobes. The flowers are produced in loose spikes at the end of the branches; they are small and white, so make no great appearance. These are succeeded by oval berries as large as middling cherries, sometimes single, at others, two, three, or four are joined together; these have a saponaceous skin or cover, which incloses a very smooth roundish nut of the same form, of a shining black when ripe. The skin, or pulp, which surrounds the nuts, is used in America to wash linen; but it is very apt to burn and destroy it if often used, being of a very acrid nature.

SAPONARIA, in botany, *soap-wort*, a genus of the Decandria Digynia class and order. Natural order of Caryophyllei. Caryophylleæ, Jussieu. Essential character: calyx one-leafed, naked; petals five, clawed; capsule oblong, one-celled. There are nine species. S. officinalis, a British plant, has a creeping root, so that in a short time it would fill a large space of ground. The stalks are above two feet high, and of a purplish colour. The foot-stalks of the flowers arise from the wings of the leaves opposite; they sustain four, five, or more purple flowers each, which have generally two small leaves placed under them. The stalk is also terminated by a loose bunch of flowers growing in form of an umbel; they have each a large swelling cylindrical empalement, and five broad obtuse petals, which spread open, of a purple colour. These are succeeded by oval capsules, with one cell filled with small seeds. The decoction of this plant is used to cleanse and scour woollen cloths: the poor people in some countries use it instead of soap for washing; from which use it had its name.

SAPPHIRE. See CORUNDUM, where we have given the analysis of the blue corundum, or sapphire. It is infusible without addition before the blow-pipe, but with borax it melts with effervescence. Sapphire, and oriental ruby, of which an analysis is also given in the article CORUNDUM, are next to the diamond, the most valuable of precious stones, and are used in the finest kind of jewelry. The oriental ruby differs from the sapphire in its colour: it is also softer and of less specific gravity. In its geognostic character, it differs also from the ruby, as it occurs sometimes imbedded in corundum, which is an inmate of primitive mountains, while sapphire appears to be a production of a later period. The violet coloured sapphire is the oriental amethyst: the yellow, the oriental chrysolite and topaz; and the green, the oriental emerald.

SARACA, in botany, a genus of the Diadelphia Hexandria class and order. Natural order of Lomentaceæ. Essential character: calyx none; corolla funnel-form, four-cleft; filaments three on each side the throat; legume pedicelled. There is but one species, viz. S. indica, a native of the East Indies.

SARCOCOL, in chemistry, a gum resin, supposed to be the product of the penæa sarcocolla. It is brought from Persia and Arabia, in the form of small grains: they have sweet and bitterish taste, and are very soluble in water.

SARMENTACACEÆ, in botany, the name of the eleventh class in Linnæus's Fragments of a Natural Method, consisting of plants that have climbing stems and branches, which like the vine attach themselves to the bodies in their neighbourhood for the purpose of support.

SAROTHRA, in botany, a genus of the Pentandria Trigynia class and order. Natural order of Rotaceæ. Caryophylleæ, Jussieu. Essential character: calyx, five parted; corolla five petalled; capsule one-celled, three-valved, coloured. There is but one species, viz. S. gentianoides an an-

nual plant, and a native of Virginia and Pennsylvania, growing abundantly in the fields, and under the bushes, in a dry sandy ground, near the capital of the latter province.

SARRACENIA in botany, *side-saddle flower*, so named in honour of Dr. Sarrazin, professor of botany, a genus of the Polyandria Monogynia class and order. Natural order of Succulentæ. Essential character: calyx double, three-leaved, and five-leaved; corolla, five-petalled, capsule, five-celled, with the style having a clypeate stigma. There are four species, all natives of North America.

SARSAPARILLA, in pharmacy, the root of the rough smilax of Peru, consisting of a great number of long strings hanging from one head: these long roots, the only parts made use of, are about the thickness of a goose-quill, or thicker, flexible, and composed of fibres running their whole length: they have a bitterish but not ungrateful taste and no smell: and as to their medicinal virtues, they are sudorific and attenuant, and should be given in decoction, or by way of diet-drink.

SASH, a mark of distinction, which in the British service is generally made of crimson silk for the officers, and of crimson mixed with white cotton for the serjeants. It is worn round the waist in most regiments, in some few, particularly in the Highland corps, it is thrown across the shoulder. Sashes were originally invented for the convenience and ease of wounded officers, &c. by means of which, in case any of them were so badly wounded as to render them incapable of remaining at their posts, they might be carried off with the assistance of two men. They are now reduced to a very small size, and of course unfit for the original purpose. Both the sash and gorget, indeed, must be considered as mere marks of distinction, to point out officers on duty. In some instances they are worn together; in others, the gorget is laid aside, and the sash only worn. The British cavalry tie the sash on the right, the infantry on the left side. The sashes for the imperial army are made of crimson and gold, for the Prussian army black silk and silver, the Hanoverians yellow silk, the Portuguese crimson silk with blue tassels. The French have their sashes made of three colours, viz. white, pink, and light-blue, to correspond with the national flag.

SASSAFRAS, in pharmacy, the wood of an American tree, of the laurel-kind, imported in large straight blocks: it is said to be warm, aperient, and corroborant; and frequently employed, with good success, for purifying the blood, for which purpose an infusion, in the way of tea, is a very pleasant drink: its oil is very fragrant, and possesses most of the virtues of the wood.

SATELLITES, in astronomy, are certain secondary planets, moving round the other planets, as the Moon does round the Earth. They are so called because they always attend them, and make the tour about the Sun together with them. The words moon and satellite are sometimes used indifferently: thus we say, either Jupiter's moons, or Jupiter's satellites; but usually we distinguish, restraining the term moon to the Earth's attendant, and applying the term satellite to the little moons more recently discovered about Jupiter, Saturn, and the Herschel planet, by the assistance of the telescope, which is necessary to render them visible.

The satellites move round their primary planets, as their centres, by the same laws as those primary ones do round their centre the Sun; *viz.* in such manner that, in the satellites of the same planet, the squares of the periodic times are proportional to the cubes of their distances from the primary planet.

SATELLITES *of Jupiter*, are four little moons, or secondary planets performing their revolutions about Jupiter, as that planet does about the Sun.

Simon Marius, mathematician of the Elector of Brandenburg, about the end of November 1609, observed three little stars moving round Jupiter's body, and proceeding along with him; and in January 1610, he found a fourth. In January 1610, Galileo also observed the same in Italy, and in the same year published his observations. These satellites were also observed in the same month of January 1610, by Thomas Harriot, the author of a work upon algebra, and who made constant observations on these satellites, from that time till the 26th of February 1612.

When Jupiter comes into a line between any of his satellites and the Sun, the satellite disappears, being then eclipsed, or involved in his shadow. When the satellite goes behind the body of Jupiter, with respect to an observer on the Earth, it is then said to be occulted, being hidden from our sight by his body, whether in his shadow or not. And when the satellite comes into a position between Jupiter and the Sun, it casts

a shadow upon the face of that planet, which we see as an obscure round spot. And lastly, when the satellite comes into a line between Jupiter and us, it is said to transit the disc of the planet, upon which it appears as a round black spot. The periods or revolutions of Jupiter's satellites, are found out from their conjunctions with that planet, after the same manner as those of the primary planets are discovered from their opposition to the Sun. And their distances from the body of Jupiter, are measured by a micrometer, and estimated in semi-diameters of that planet, and thence in miles. The periodical times and distances of these satellites, and the angles under which their orbits are seen from the Earth, at its mean distance from Jupiter, are as below.

Satellites.	Periodic Times.	Distances in Semidiameter	Distances in Miles.	Angles of Orbit.
1	$1^d\ 18^h\ 27'\ 34''$	$5\frac{2}{3}$	266,000	$3'\ 55''$
2	3 13 13 42	$9\frac{1}{10}$	423,000	6 14
3	7 3 42 36	$14\frac{5}{13}$	676,000	9 58
4	16 16 32 9	$25\frac{1}{18}$	1,189,000	17 30

The eclipses of the satellites, especially of those of Jupiter, are of very great use in astronomy. First, in determining pretty exactly the distance of Jupiter from the Earth. A second advantage still more considerable, which is drawn from these eclipses, is the proof which they give of the progressive motion of light. It is demonstrated by these eclipses, that light does not come to us in an instant, although its motion is extremely rapid. For if the motion of light were infinite, or came to us in an instant, it is evident that we should see the commencement of an eclipse of a satellite at the same moment, at whatever distance we might be from it; but, on the contrary, if light move progressively, then it is as evident, that the further we are from a planet, the later we shall be in seeing the moment of its eclipse, because the light will take up a longer time in arriving at us; and so it is found in fact to happen, the eclipses of these satellites appearing always later and later than the true computed times, as the Earth removes further and further from the planet. When Jupiter and the Earth are at their nearest distance, being in conjunction both on the same side of the Sun, then the eclipses are seen to happen the soonest; and when the Sun is directly between Jupiter and the Earth, they are at their greatest distance asunder, the distance being more than before by the whole diameter of the Earth's annual orbit, or by double the Earth's distance from the Sun, then the eclipses are seen to happen the latest of any, and later than before by about a quarter of an hour. Hence therefore it follows, that light takes up a quarter of an hour in travelling across the orbit of the Earth, or nearly eight minutes in passing from the Sun to the Earth; which gives us about 12 millions of miles per minute, or 200,000 miles per second, for the velocity of light. A discovery that was first made by M. Roemer.

The third and greatest advantage derived from the eclipses of the satellites, is the knowledge of the longitudes of places on the Earth. Suppose two observers of an eclipse, the one, for example, at London, the other at the Canaries; it is certain that the eclipse will appear at the same moment to both observers; but as they are situated under different meridians, they count different hours, being perhaps 9 o'clock to the one, when it is only 8 to the other; by which observations of the true time of the eclipse, on communication, they find the difference of their longitudes to be one hour in time, which answers to 15 degrees of longitude.

Saturn has seven secondary planets revolving about him. One of them, which till lately was reckoned the fourth in order from Saturn, was discovered by Huygens, the 25th of March, 1655, by means of a telescope 12 feet long; and the first, second, third, and fifth, at different times, by Cassini, *viz.* the fifth in October, 1671, by a telescope of 17 feet; the third in December, 1672, by a telescope of Campani's, 35 feet long; and the first and second in March, 1684, by help of Campani's glasses, of 100 and 136 feet. Finally, the sixth and seventh satellites were discovered by Dr. Herschel, with his 40 feet reflecting telescope, *viz.* the sixth on the 19th of August, 1787, and the seventh on the 17th of September, 1788. These two he has called the sixth and seventh satellites, though they are nearer to the planet Saturn than any of the former five, that the names or numbers of these might not be mistaken or confounded, with regard to former observations of them.

Moreover, the great distance between the fourth and fifth satellite, gave occasion

to Huygens to suspect that there might be some intermediate one, or else that the fifth might have some other satellite moving round it, as its centre. Dr. Halley, in the Philosophical Transactions, gives a correction of the theory of the motions of the fourth or Huygenian satellite. Its true period he makes 11ᵈ 22ʰ 41′ 6″.

The periodical revolutions, and distances of the satellites from the body of Saturn, expressed in semidiameters of that planet, and in miles, are as follow :

Satellites.	Periods.	Distances in Semidiameters.	Distances in Miles.	Diam. of Orbit.
1	1ᵈ 21ʰ 18′ 27″	4⅜	170,000	1′ 27″
2	2 17 41 22	5½	217,000	1 52
3	4 12 25 12	8	303,000	2 36
4	15 22 41 13	18	704,000	6 18
5	79 7 48 0	54	2,050,000	17 4
6	1 8 53 9	3¼	135,000	1 14
7	0 22 40 46	2⅙	107,000	0 57

The four first describe ellipaes like to those of the ring, and are iu the same plane. Their inclination to the ecliptic is from 30 to 31 degrees. The fifth describes an orbit inclined from 17 to 18 degrees with the orbit of Saturn ; his plane lying between the ecliptic and those of the other satellites, &c. Dr. Herschel observes that the fifth satellite turns once round its axis exactly in the time in which it revolves about the planet Saturn ; in which respect it resembles our Moon, which does the same thing. And he makes the angle of its distance from Saturn, at his mean distance, 17′ 2″. Philosophical Transactions, 1792, p. 22. See a long account of observations of these satellites, with tables of their mean motions, by Dr. Herschel. Philosophical Transaction, 1790.

The Herschel has six satellites, or moons, that revolve about him, like those of Jupiter and Saturn. These satellites were discovered by Dr. Herschel, who gave an account of them in the Philosophical Transactions.

SATIN, a glossy kind of silk stuff, the warp of which is very fine, and stands out so as to cover the coarser woof. Some satins are quite plain, others wrought; some flowered with gold or silver, and others striped, &c. The Chinese satins are most valued, because of their cleaning and bleaching easily, without losing any thing of their lustre ; in other respects they are inferior to those of Europe.

SATINET, a slight thin kind of satin, commonly striped, and chiefly used by the ladies for summer night gowns.

SATURATION, in chemistry. As there are certain limits to the proportions in which bodies combine together, beyond which they cannot pass, these are called the points of saturation ; and when two bodies, in uniting together, have reached this point, they are said to be saturated, or the one body is said to be saturated with the other ; in other words, the change has taken place, and a new compound is formed. When, for instance, a salt is dissolved in water, as common salt, the water combines only with a certain proportion ; and whatever quantity of salt is added beyond this proportion, it falls to the bottom undissolved. The reason of this is, that the particles of the salt are held together by their affinity for each other ; that is, by the force of cohesion. Now, before any combination can be effected between the particles of the salt and the water, this force must be overcome. The force of affinity, therefore, between the water and the particles of salt, is greater than that between the particles of salt themselves, and thus they are separated and dissolve in the water ; but this force of affinity between the water and the salt is limited ; and when it has arrived at its utmost limit, the action between the two bodies ceases. The two forces which were opposed to each other ; that is, the force of affinity between the water and the salt on the one hand, and the force of cohesion between the particles of the salt on the other, are balanced. The water in this case is said to be saturated with salt.

SATUREIA, in botany, *savory*, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character : corolla with segments nearly equal ; stamina distant. There are eight species, S. hortensis, or summer savory, is an annual plant, which grows naturally in the south of France and Italy, but is cultivated in this country both for the kitchen and medicinal use. The S. montana, or winter savory, a perennial plant, growing naturally in the south of France and Italy, but is cultivated in gardens both for culinary and medicinal purposes. Both kinds are propagated by seeds. Summer savory is a very warm pungent aromatic, and affords in distillation with water a subtile essential oil, of a

penetrating smell, and very hot acrid taste.

SATURN is a very conspicuous planet, though not so brilliant as Jupiter. The period of his sidereal revolution round the earth is 10,759 days. He moves from west to east nearly in the plane of the ecliptic, and exhibits irregularities similar to those of Jupiter and Mars. He becomes retrograde both before and after his opposition, when at the distance of about 109° from the Sun. His retrograde motion continues about 139 days, and during its continuance he describes an arc of about 6°. His diameter is a maximum at his opposition, and his mean apparent diameter is 18″. Saturn, when viewed through a good telescope, makes a more remarkable appearance than any of the other planets. Galileo first discovered his uncommon shape, which he thought to be like two small globes, one on each side of a large one, and he published his discovery in a Latin sentence, the meaning of which was, that he had seen him appear with three bodies, though, in order to keep the discovery a secret, the letters were transposed. Having viewed him for two years, he was surprised to see him become quite round, without these appendages, and then, after some time to assume them as before. These adjoining globes were what are now called the ansæ of his ring, the true shape of which was first discovered by Huygens, about forty years after Galileo, first with a telescope of twelve feet, and then with one of twenty-three feet, which magnified objects one hundred times. From the discoveries made by him and other astronomers, it appears that this planet is surrounded by a broad thin ring, the edge of which reflects little or none of the Sun's light to us, but the planes of the ring reflect the light in the same manner that the planet itself does, and if we suppose the diameter of Saturn to be divided into three equal parts, the diameter of the ring is about seven of these parts. The ring is detached from the body of Saturn in such a manner, that the distance between the innermost part of the ring and the body is equal to its breadth. Both the outward and inward rim of the ring is projected into an ellipse, more or less oblong, according to the different degrees of obliquity with which it is viewed. Sometimes our eye is in the plane of the ring, and then it becomes invisible, either because the outward edge is not fitted to reflect the Sun's light, or more probably because it is too thin to be seen at such a distance. As the plane of this ring keeps always parallel to itself, that is, its situation in one part of the orbit is always parallel to that in any other part, it disappears twice in every revolution of the planet, that is, about once in fifteen years, and he sometimes appears quite round for nine months together. At other times, the distance between the body of the planet and the ring is very perceptible, insomuch that Mr. Whiston tells us of Dr. Clarke's father having seen a star through the opening, and supposed him to have been the only person who ever saw a sight so rare, as the opening, though certainly very large, appears very small to us.

When Saturn appears round, if our eye be in the plane of the ring, it will appear as a dark line across the middle of the planet's disc, and if our eye be elevated above the plane of the ring, a shadowy belt will be visible, caused by the shadow of the ring as well as by the interposition of part of it between the eye and the planet. The shadow of the ring is broadest when the Sun is most elevated, but its obscure parts appear broadest when our eye is most elevated above the plane of it. When it appears double, the ring next the body of the planet appears brightest. When the ring appears of an elliptical form, the parts about the ends of the largest axis are called the ansæ, as has been already mentioned. These, a little before and after the disappearing of the ring, are of unequal magnitude; the largest ansa is longer visible before the planet's round phase, and appears again sooner than the other. On the first of October, 1714, the largest ansa was on the east side, and on the twelfth on the west side of the disc of the planet, which makes it probable that the ring has a rotation round an axis. Herschel has demonstrated, that it revolves in its own plane in $10^h\ 32'\ 15.4''$. The observations of this philosopher have added greatly to our knowledge of Saturn's ring. According to him there is one single, dark, considerably broad line, belt, or zone, which he has constantly found on the north side of the ring. As this dark belt is subject to no change whatever, it is probably owing to some permanent construction of the surface of the ring: this construction cannot be owing to the shadow of a chain of mountains, since it is visible all round on the ring, for there could be no shade at the ends of the ring; a similar argument will apply against the opinion of very extended caverns. It is pretty evident that this dark zone is con-

tained between two concentric circles, for all the phenomena correspond with the projection of such a zone. The nature of the ring Dr. Herschel thinks no less solid than that of Saturn itself, and it is observed to cast a strong shadow upon the planet. The light of the ring is also generally brighter than that of the planet, for the ring appears sufficiently bright when the telescope affords scarcely light enough for Saturn. The Doctor concludes that the edge of the ring is not flat, but spherical, or spheroidical. The dimensions of the ring, or of the two rings with the space between them, Dr. Herschel gives as below:

Inner diameter of smaller ring	146,345
Outside diameter of ditto	184,393
Inner diameter of larger ring	190,248
Outside diameter of ditto	204,883
Breadth of the inner ring	20,000
Breadth of the outer ring	7,200
Breadth of the vacant space, or dark zone	2,839

There have been various conjectures relative to the nature of this ring. Some persons have imagined that the diameter of the planet Saturn was once equal to the present diameter of the outer ring, and that it was hollow: the present body being contained within the former surface, in like manner as a kernel is contained within its shell; they suppose that, in consequence of some concussion, or other cause, the outer shell all fell down to the inner body, and left only the ring at the greater distance from the centre, as we now perceive it. This conjecture is in some measure corroborated by the consideration that both the planet and its ring perform their rotations about the same common axis, and in very nearly the same time. But from the observations of Dr. Herschel, he thus concludes: "It does not appear to me that there is sufficient ground for admitting the ring of Saturn to be of a very changeable nature, and I guess that its phenomena will hereafter be so fully explained, as to reconcile all observations. In the meanwhile we must withhold a final judgment of its construction, till we can have more observations. Its division, however, into two very unequal parts, can admit of no doubt." The diameters of Saturn are not equal: that which is perpendicular to the plane of his ring appears less by one-eleventh than the diameter situated in that plane. If we compare this form with that of Jupiter, we have reason to conclude that Saturn turns rapidly round his shorter axis, and that the ring moves in the plane of his equator. Herschel has confirmed this opinion by actual observation. He has ascertained the duration of a revolution of Saturn round his axis to amount to 0.428 day. Huygens observed five belts upon this planet nearly parallel to the equator.

SATYRIUM, in botany, a genus of the Gynandria Diandria class and order. Natural order of Orchideæ. Essential character: nectary scrotiform, or twin-inflated behind the flower. There are twenty-one species.

SAUCISSE, or Sausage, in the military art, a long train of powder, sewed up in a roll of pitched cloth, about two inches in diameter, serving to set fire to mines. There are usually two saucisses extended from the chamber of the mine to the place where the engineer stands; that in case one should fail, the other may take effect.

SAUCISSON, in fortification, a mass of large branches of trees bound together; and differing only from a fascine, as this is composed of small branches of twigs. Saucissons are employed to cover the men, and to make epaulements.

SAVILLE (Sir Henry), in biography, a very learned Englishman, the second son of Henry Saville, Esq. was born at Bradley, near Halifax, in Yorkshire, November the 30th, 1549. He was entered of Merton College, Oxford, in 1561, where he took the degrees in arts, and was chosen fellow. When he proceeded master of arts, in 1570, he read, for that degree, on the Almagest of Ptolemy, which procured him the reputation of a man eminently skilled in mathematics, and the Greek language; in the former of which he voluntarily read a public lecture in the University for some time.

In 1578, he travelled into France, and other countries; where, diligently improving himself in all useful learning, in languages, and the knowledge of the world, he became a most accomplished gentleman. At his return, he was made tutor in the Greek tongue to Queen Elizabeth, who had a great esteem and respect for him.

In 1585, he was made Warden of Merton College, which he governed six and thirty years with great honour, and improved it by all the means in his power. In 1596, he was chosen Provost of Eton College; which he filled with many learned men. James I. upon his accession to the crown of England, expressed a great regard for him, and would have preferred him

either in church or state; but Saville declined it, and only accepted the ceremony of knighthood from the King, at Windsor, in 1604. His only son, Henry, dying about that time, he henceforth devoted his fortune to the promoting of learning. Among other things, in 1619, he founded, in the University of Oxford, two lectures, or professorships, one in geometry, the other in astronomy; which he endowed with a salary of 160*l.* a year each, besides a legacy of 600*l.* to purchase more lands for the same use. He also furnished a library with mathematical books, near the mathematical school, for the use of his professors; and gave 100*l.* to the mathematical chest of his own appointing; adding afterwards a legacy of 40*l.* a year to the same chest, to the University, and to his professors jointly. He likewise gave 120*l.* towards the new building of the schools, beside several rare manuscripts and printed books to the Bodleian Library; and a good quantity of Greek types to the printing press at Oxford.

After a life thus spent in the encouragement and promotion of science and literature in general, he died at Eton College, the 19th of February, 1622, in the seventy-third year of his age, and was buried in the chapel there. On this occasion the University of Oxford paid him the greatest honours, by having a public speech and verses made in his praise, which were published soon after in 4to. under the title of "Ultima Linea Savilii."

As to the character of Saville, the highest encomiums are bestowed upon him by all the learned of his time; by Casaubon, Mercerus, Meibomius, Joseph Scaliger, and especially the learned Bishop Montague, who, in his "Diatribæ upon Selden's History of Tythes," styles him, "that magazine of learning, whose memory shall be honourable amongst not only the learned, but the righteous for ever."

Several noble instances of his munificence to the republic of letters have already been mentioned: in the account of his publications many more, and even greater, will appear. These are,

1. Four Books of the Histories of Cornelius Tacitus, and the Life of Agricola, with Notes upon them, in folio; dedicated to Queen Elizabeth, 1581.

2. A View of certain Military Matters, or Commentaries respecting Roman Warfare. 1598.

3. Rerum Anglicarum Scriptores post Bedam, &c. 1596. This is a collection of the best writers of our English History, to which he added chronological tables at the end, from Julius Cæsar to William the Conqueror.

4 The Works of St. Chrysostom, in Greek, in eight volumes, folio, 1613. This is a very fine edition, and composed with great cost and labour. In the preface he says, "that having himself visited, about twelve years before, all the public and private libraries in Britain, and copied out thence whatever he thought useful to this design, he then sent some learned men into France, Germany, Italy, and the East, to transcribe such parts as he had not already, and to collate the others with the best manuscripts." At the same time he makes his acknowledgements to several eminent men for their assistance; as Thuanus, Velserus, Schottus, Casaubon, Ducæus, Gruter, Hoeschelius, &c. In the eighth volume are inserted Sir Henry Saville's own notes, with those of other learned men. The whole charge of this edition, including the several sums paid to learned men, at home and abroad, employed in finding out, transcribing, and collating the best manuscripts, is said to have amounted to no less than 8,000*l.* Several editions of this work were afterwards published at Paris.

5. In 1618 he published a Latin work, written by Thomas Bradwardin, Archbishop of Canterbury, against Pelagius, entitled De Causa Dei contra Pelagium, et de virtute Causarum; to which he prefixed the Life of Bradwardin.

6. In 1621 he published a Collection of his own Mathematical Lectures on Euclid's Elements; in 4to.

7. Oratio coram Elizabetha Regina Oxoniæ habita, anno 1592. Printed at Oxford in 1658. 4to.

8. He translated into Latin King James's Apology for the Oath of Allegiance. He also left several manuscripts behind him, written by order of King James; all which are in the Bodleian Library. He wrote notes likewise upon the margin of many books in his library, particularly Eusebius's Ecclesiastical History; which were afterwards used by Valesius, in his edition of that work in 1659. Four of his Letters to Camden are published by Smith, among Camden's Letters. 1691. 4to.

SAUNDERS, or SANDERS. See SANTALUM.

SAUNDERSON (Dr. NICHOLAS), in biography, an illustrious professor of mathematics in the University of Cambridge, and

a fellow of the Royal Society, was born at Thurlston in Yorkshire in 1682. When he was but twelve months old, he lost not only his eye-sight, but his very eye-balls, by the small pox; so that he could retain no more ideas of vision than if he had been born blind. At an early age, however, being of very promising parts, he was sent to the free school at Penniston, and there laid the foundation of that knowlege of the Greek and Latin languages, which he afterwards improved so far, by his own application to the classic authors, as to hear the works of Euclid, Archimedes, and Diophantes read in their original Greek.

Having acquired a grammatical education, his father, who was in the excise, instructed him in the common rules of arithmetic. And here it was that his excellent mathematical genius first appeared; for he very soon became able, to work the common questions, to make very long calculations by the strength of his memory, and to form new rules to himself for the better resolving of such questions as are often proposed to learners as trials of skill.

At the age of eighteen, our author was introduced to the acquaintance of Richard West, of Underbank, Esq., a lover of mathematics, who, observing Mr. Saunderson's uncommon capacity, took the pains to instruct him in the principles of algebra, and geometry, and gave him every encouragement in his power to the prosecution of these studies. Soon after this he became acquainted also with Dr. Nettleton, who took the same pains with him. And it was to these two gentlemen that Mr. Saunderson owed his first institution in the mathematical sciences; they furnished him with books, and often read and expounded them to him. But he soon surpassed his masters, and became fitter to teach, than to learn any thing from them.

His father, otherwise burthened with a numerous family, finding a difficulty in supporting him, his friends began to think of providing both for his education and maintenance. His own inclination led him strongly to Cambridge, and it was at length determined he should try his fortune there, not as a scholar, but as a master: or, if this design should not succeed, they promised themselves success in opening a school for him at London. Accordingly he went to Cambridge in 1707, being then twenty-five years of age, and his fame in a short time filled the University. Newton's Principia, Optics, and Universal Arithmetic, were the foundations of his lectures, and afforded him a noble field for the display of his genius; and great numbers came to hear a blind man give lectures on optics, discourse on the nature of light and colours, explain the theory of vision, the effect of glasses, the phenomenon of the rainbow, and other objects of sight.

As he instructed youth in the principles of the Newtonian philosophy, he soon became acquainted with its incomparable author, though he had several years before left the University; and frequently conversed with him on the most difficult parts of his works: he also held a friendly communication with the other eminent mathematicians of the age, as Halley, Cotes, De Moivre, &c.

Mr. Whiston was all this time in the mathematical professor's chair, and read lectures in the manner proposed by Mr. Saunderson on his settling at Cambridge; so that an attempt of this kind looked like an encroachment on the privilege of his office; but, as a good natured man, and an encourager of learning; he readily consented to the application of friends made in behalf of so uncommon a person.

Upon the removal of Mr. Whiston from his professorship, Mr. Saunderson's merit was thought so much superior to that of any other competitor, that an extraordinary step was taken in his favour, to qualify him with a degree, which the statute requires: in consequence he was chosen, in 1711, Mr. Whiston's successor in the Lucasian professorship of mathematics; Sir Isaac Newton interesting himself greatly in his favour. His first performance, after he was seated in the chair, was an inaugural speech made in very elegant Latin, and a style truly Ciceronian; for he was very well versed in the writings of Tully, who was his favourite in prose, as Virgil and Horace were in verse. From this time he applied himself closely to the reading of lectures, and gave up his whole time to his pupils. He continued to reside among the gentlemen of Christ College till the year 1723, when he took a house in Cambridge, and soon after married a daughter of Mr. Dickens, rector of Boxworth, in Cambridgeshire, by whom he had a son and a daughter.

In the year 1728, when King George visited the university, he expressed a desire of seeing so remarkable a person; and accordingly our professor attended the king in the senate, and by his favour was there created doctor of laws.

Dr. Saunderson was naturally of a strong healthy constitution; but being too sedentary, and constantly confining himself to the house, he became a valetudinarian: and in the spring of the year 1739 he complained of a numbness in his limbs, which ended in a mortification in his foot, of which he died the 19th of April that year, in the 57th year of his age.

There was scarcely any part of the mathematics on which Dr. Saunderson had not composed something for the use of his pupils. But he discovered no intention of publishing any thing, till, by the persuasion of his friends, he prepared his Elements of Algebra for the press; which, after his death, were published by subscription in 2 vols. 4to. 1740.

He left many other writings, though none perhaps prepared for the press. Among these were some valuable comments on Newton's Principia, which not only explain the more difficult parts, but often improve upon the doctrines. These are published in Latin at the end of his posthumous Treatise on Fluxions, a valuable work, published in 8vo, 1756. His manuscript lectures too, on most parts of natural philosophy, might make a considerable volume, and prove an acceptable present to the public if printed.

Dr. Saunderson, as to his character, was a man of much wit and vivacity in conversation, and esteemed an excellent companion. He was endued with a great regard to truth, and was such an enemy to disguise, that he thought it his duty to speak his thoughts at all times with unrestrained freedom. Hence his sentiments on men and opinions, his friendship or disregard, were expressed without reserve; a sincerity which raised him many enemies.

A blind man, moving in the sphere of a mathematician, seems a phenomenon difficult to be accounted for, and has excited the admiration of every age in which it has appeared. Tully mentions it as a thing scarcely credible in his own master in philosophy, Diodotus; that he exercised himself in it with more assiduity after he became blind; and, what he thought next to impossible to be done without sight, that he professed geometry, describing his diagrams so exactly to his scholars, that they could draw every line in its proper direction. St. Jerome relates a still more remarkable instance in Didymus of Alexandria, who, though blind from his infancy, and therefore ignorant of the very letters, not only learned logic, but geometry also, to a very great perfection, which seems most of all to require sight. But, if we consider that the ideas of extended quantity, which are the chief objects of mathematics, may as well be acquired by the sense of feeling as that of sight, that a fixed and steady attention is the principal qualification for this study, and that the blind are, by necessity, more abstracted than others, (for which reason, it is said, that Democritus put out his eyes, that he might think more intensely), we shall perhaps find reason to suppose that there is no branch of science so much adapted to their circumstances.

At first, Dr. Saunderson acquired most of his ideas by the sense of feeling; and this, as is commonly the case with the blind, he enjoyed in great perfection. Yet he could not, as some are said to have done, distinguish colours by that sense; for, after having made repeated trials, he used to say, it was pretending to impossibilities. But he could with great nicety and exactness observe the smallest degree of roughness, or defect of polish, in a surface. Thus, in a set of Roman medals, he distinguished the genuine from the false, though they had been counterfeited with such exactness as to deceive a connoisseur who had judged from the eye. By the sense of feeling also, he distinguished the least variation; and he has been seen in a garden, when observations have been making on the sun, to take notice of every cloud that interrupted the observation, almost as justly as they who could see it. He could also tell when any thing was held near his face, or when he passed by a tree at no great distance, merely by the different impulse of the air on his face.

His ear was also equally exact. He could readily distinguish the 5th part of a note. By the quickness of this sense he could judge of the size of a room, and of his distance from the wall. And if ever he walked over a pavement, in courts or piazzas which reflected a sound, and was afterwards conducted thither again, he could tell in what part of the walk he had stood merely by the note it sounded.

Dr. Saunderson had a peculiar method of performing arithmetical calculations, by an ingenious machine and method which has been called his Palpable Arithmetic, and is particularly described in a piece prefixed to the first volume of his Algebra. That he was able to make long and intricate calculations, both arithmetical and algebraical,

is a thing as certain as it is wonderful. He had contrived for his own use a commodious notation for any large numbers, which he could express on his abacus, or calculating table, and with which he could readily perform any arithmetical operations, by the sense of feeling only, for which reason it was called his Palpable Arithmetic.

His calculating table was a smooth thin board, a little more than a foot square, raised upon a small frame, so as to lie hollow, which board was divided into a great number of little squares, by lines intersecting one another perpendicularly, and parallel to the sides of the table, and the parallel ones only one-tenth of an inch from each other, so that every square inch of the table was thus divided into 100 little squares. At every point of intersection the board was perforated by small holes, capable of receiving a pin; for it was by the help of pins stuck up to the head through these holes, that he expressed his numbers. He used two sorts of pins, a large and a smaller sort, at least their heads were different, and might easily be distinguished by feeling. Of these pins he had a large quantity in two boxes, with their points cut off, which always stood ready before him when he calculated. The writer of that account describes particularly the whole process of using the machine, and concludes; "He could place and displace his pins with incredible nimbleness and facility, much to the pleasure and surprise of all the beholders. He could even break off in the middle of a calculation, and resume it when he pleased, and could presently know the condition of it, by only drawing his fingers gently over the table."

SAURURUS, in botany, a genus of the Heptandria Trigynia class and order. Natural order of Piperitæ. Naiades, Jussieu. Essential character: calyx an ament with one-flowered scales, corolla none; germs four; berries four, one seeded. There is but one species; viz. S. cernuus, lizard's tail, a native of North America.

SAUVAGESIA, in botany, so named in honour of Francois Boissier de Sauvages, professor at Montpellier, a genus of the Pentandria Monogynia class and order. Natural order of Gruinales. Essential character: calyx five-leaved; corolla five-petalled, fringed; nectary five-leaved, alternate with the petals, capsule one-celled. There is but one species, viz. S. erecta, a native of St. Domingo, Martinico, Jamaica, Surinam, and Guiana.

SAW, an instrument which serves to cut into pieces several solid matters, as wood, stone, ivory, &c. The best saws are of tempered steel ground bright and smooth: those of iron are only hammer-hardened: hence, the first, besides their being stiffer, are likewise found smoother than the last. They are known to be well hammered by the stiff bending of the blade; and to be well and evenly ground, by their bending equally in a bow. The edge in which are the teeth is always thicker than the back, because the back is to follow the edge. The teeth are cut and sharpened with a triangular file, the blade of the saw being first fixed in a whetting block. After they have been filed the teeth are set, that is, turned out of the right line, that they may make the fissure the wider, that the back may follow the better. The teeth are always set ranker for coarse cheap stuff than for hard and fine, because the ranker the teeth are set the more stuff is lost in the kerf. The saws by which marble and other stones are cut have no teeth: these are generally very large, and are stretched out and held even by a frame. The workmen who make the greatest use of the saw, are the sawyers, carpenters, joiners, cabinet-makers, ebonists, stone-cutters, carvers, sculptors, &c. The lapidaries too have their saw, as well as the workers in mosaic, but these bear little resemblance to the common saw. But of all mechanics, none have so many saws as the joiners; the chief are as follows: the pit saw, which is a large two-handed saw, used to saw timber in pits; this is chiefly used by the sawyers. The whip-saw, which is also two-handed, used in sawing such large pieces of stuff as the hand-saw will not easily reach. The hand-saw, which is made for a single man's use, of which there are various kinds; as the bow or frame saw, which is furnished with cheeks: by the twisted cords which pass from the upper parts of these cheeks, and the tongue in the middle of them, the upper ends are drawn closer together, and the lower set further apart. The tenon-saw, which being very thin, has a back to keep it from bending. The compass saw, which is very small, and its teeth usually not set: its use is to cut a round, or any other compass-kerf: hence the edge is made broad and the back thin, that it may have a compass to turn in.

The surgeons also use a saw to cut off bones, this should be very small and light, in order to be managed with the greater ease and freedom, the blade exceedingly fine,

and the teeth exquisitely sharpened, to make its way more gently, and yet with great expedition, in cutting off legs, arms, &c.

Saws are now generally used by butchers in separating the bones of the meat; the divisions by the saw are neater than those by the chopper, and there is a certain saving, as the chopper splinters bones, the parts of which cannot be included in the weight.

SAWING, dividing timber, &c. by the application of a saw, either by the hand or mill. The mechanism of a sawing-mill may be reduced to three principal things, the first, that the saw be drawn up and down as long as is necessary, by a motion communicated by water to the wheel: the second, that the piece of timber to be cut into boards be advanced by an uniform motion to receive the strokes of the saw; for here the wood is to meet the saw, and not the saw to follow the wood, therefore the motion of the wood and that of the saw ought immediately to depend the one on the other: the third, that when the saw has cut through the whole length of the piece, the machine stops of itself, and remains immoveable; for fear, lest having no obstacle to surmount, the force of the water, or steam, should turn the wheel with too great rapidity, and break some part of the machine.

In Plate Saw-mill are drawings of a circular saw-mill, used by Mr. George Smart, at his manufactory for hollow-made masts, Westminster Bridge. Fig. 1 is an elevation of the machine; fig. 2, a plan; and fig. 3 and 4, the saw shown separately.

The machine is turned by a horse-wheel, which gives motion to a pinion on a horizontal shaft; a spur wheel is fixed on this shaft, and turns a pinion on another horizontal shaft, on which the wheel A, (fig. 1) is fixed: this wheel is in the room over the machine, and the bearings for the gudgeons of the shaft are supported on the joists, B, of the floor: by means of an endless strap passing round this wheel, and also round a pulley, N, on the spindle of the circular saw, a rapid motion is given to the saw, which is made of well-tempered steel plate (fig. 3), with teeth on its edge: it is fixed on its spindle, D, (fig. 4) by a shoulder, *d*, against which it is held by another moveable shoulder, *e*, pressed against the other by a nut, *k*, on the end of the spindle which is tapped into a screw to receive it. The saw has a a circular hole through the middle, fitting tight upon the spindle, and a small fillet fitting into the notch, *a*, (fig. 3) causes them to turn together.

The ends of the spindle are pointed, and that point nearest the saw works in a hole made in the end of a screw screwed in a bench, E F G H, (fig. 1 and 2) made of stout planks, and well braced together; the other turns in a similar screw screwed through a cross beam, K, morticed between two vertical beams, L L, extending from the floor to the ceiling: the cross beam, K, can be raised or lowered in its mortices through the beams, L, by wedges put both above and below its tenons. In order to adjust the plane of the saw perpendicular to the plane of the bench, M M, is a long parallel ruler, which can be set at any distance from the saw, and fixed by screws going through circular grooves, *g g*, cut through the bench. In using the machine, the ruler, M M, is to be set the proper distance from the saw of the piece of wood to be cut, and as the saw turns round, a workman slides the end of a piece of wood to it, keeping its edge against the guide, M M, that it may cut straight.

When the saw requires sharpening, one of the screws at the end of its spindle must be turned back: the spindle and saw can be then removed; and by taking off the nut, *k*, the saw will be loose, and may be fixed in a common vice to whet it, in the same manner as a common saw: the teeth of the saw are set, that is, bent out of the plane of the saw, one tooth on one side, the next on the other: the outsides, *r*, (in fig. 3) of the teeth are not filed to leave a surface perpendicular to the plane of the saw, but inclined to it, and in the same direction that each tooth so filed is bent in the setting: by this means the saw, when cutting, first takes away the wood at the two sides of the kerf, leaving an angular ridge in the middle of it, the use of which is to keep the saw steady in a right line, that it may not have so much tendency to get out of the straight in any place where the wood is harder at one side than on the other.

In early periods, the trunks of trees were split with wedges into as many and as thin pieces as possible, and if it were necessary to have them still thinner, they were hewn on both sides to the proper size. This simple and wasteful manner of making boards has been still continued in some places to the present time. Peter the Great of Russia endeavoured to put a stop to it, by forbidding hewn deals to be transported on the river Neva. The saw, however, though so convenient and beneficial, has not been able to banish entirely the

practice of splitting timber used in building, or in making furniture and utensils, for we do not speak here of fire-wood; and, indeed, it must be allowed that this method is attended with peculiar advantages, which that of sawing can never possess. The wood-splitters perform their work more expeditiously than sawyers, and split timber is much stronger than that which has been sawn; for the fissure follows the grain of the wood, and leaves it whole; whereas the saw, which proceeds in the line chalked out for it, divides the fibres, and by these means lessens its cohesion and solidity. Split timber, indeed, turns out often crooked and warped; but in many purposes to which it is applied this is not prejudicial; and these faults may sometimes be amended. As the fibres, however, retain their natural length and direction, thin boards, particularly, can be bent much better. This is a great advantage in making pipe-staves, or sieve-frames, which require still more art, and in forming various implements of the like kind.

The most beneficial and ingenious improvement of this instrument was, without doubt, the invention of saw-mills, which are driven either by water or by the wind. Mills of the first kind were erected so early as the fourth century, in Germany, on the small river Roeur or Ruer: for though Ausonius speaks properly of water-mills for cutting stone, and not timber, it cannot be doubted that these were invented later than mills for manufacturing deals, or that both kinds were erected at the same time. The art, however, of cutting marble with a saw is very old. Pliny conjectures that it was invented at Caria; at least he knew no building incrusted with marble of greater antiquity than the palace of king Mausolus, at Halicarnassus. This edifice is celebrated by Vitruvius for the beauty of its marble; and Pliny gives an account of the different kinds of sand used for cutting it; for it is the sand properly, says he, and not the saw, which produces that effect. The latter presses down the former, and rubs it against the marble; and the coarser the sand is, the longer will be the time required to polish the marble which has been cut by it. Stones of the soap-rock kind, which are indeed softer than marble, and which would require less force than wood, were sawn at that period: but it appears that the far harder glassy kinds of stone were sawn then also; for we are told of the discovery of a building which was encrusted with cut agate, cornelian, lapis lazuli, and amethysts. We have, however, found no account in any of the Greek or Roman writers of a mill for sawing wood; and as the writers of modern times speak of saw-mills as new and uncommon, it would seem that the oldest construction of them has been forgotten, or that some important improvement has made them appear entirely new.

Becher, in his history of inventions, says that saw-mills were invented in the 17th century. In this he erred, for when the infant Henry sent settlers to the island of Madeira, which was discovered in 1420, and caused European fruits of every kind to be carried thither; he ordered saw-mills to be erected also, for the purpose of sawing into deals the various species of excellent timber with which the island abounded, and which were afterwards transported to Portugal. About the year 1427, the City of Breslau had a saw-mill, which produced a yearly rent of three marks; and in 1490, the magistrates of Erfurt purchased a forest in which they caused a saw-mill to be erected, and they rented another mill in the neighbourhood besides.

Norway, which is covered with forests, had the first saw-mill about the year 1530. This mode of manufacturing timber was called the new art; and because the exportation of deals was by these means increased, that circumstance gave occasion to the deal-tythe, introduced by Christian III. in the year 1545. Soon after the celebrated Henry Canzau caused the first mill of this kind to be built in Holstein. In 1552 there was a saw-mill at Joachimsthal, which, as we are told, belonged to Jacob Geusen, mathematician. In the year 1555, the bishop of Ely, ambassador from Mary queen of England to the court of Rome, having seen a saw-mill in the neighbourhood of Lyons, the writer of his travels thought it worthy of a particular description. In the sixteenth century, however, there were mills with different saw-blades, by which a plank could be cut into several deals at the same time. The first saw-mill was erected in Holland at Saardam, in the year 1596; and the invention of it is ascribed to Cornelius Cornelissen. Perhaps he was the first person who built a saw mill at that place, which is a village of great trade, and has still a great many saw-mills, though the number of them is becoming daily less; for within the last half century a hundred have been given up. The first mill of this kind in Sweden was erected

in the year 1653. At present, that kingdom possesses the largest perhaps ever constructed in Europe, where a water-wheel, twelve feet broad, drives at the same time seventy-two saws.

In England saw-mills had at first the same fate that printing had in Turkey, the ribbon-loom in the dominions of the church, and the crane at Strasburgh. When attempts were made to introduce them, they were violently opposed, because it was apprehended that the sawyers would be deprived by them of their means of getting a subsistance. For this reason, it was found necessary to abandon a saw-mill erected by a Dutchman near London, in 1663; and in the year 1700, when one Honghton laid before the nation the advantages of such a mill, he expressed his apprehension that it might excite the rage of the populace. What he dreaded was actually the case in 1767 or 1768, when an opulent timber-merchant, by the desire and approbation of the Society of Arts, caused a saw mill, driven by wind, to be erected at Limehouse, under the direction of James Stanfield, who had learned, in Holland and Norway, the art of constructing and managing machines of that kind. A mob assembled, and pulled the mill to pieces; but the damage was made good by the nation, and some of the rioters were punished. A new mill was afterwards erected, which was suffered to work without molestation, and which gave occasion to the erection of others. It appears, however, that this was not the only mill of the kind then in Britain; for one driven also by wind had been built at Leith, in Scotland, some years before.

SAXIFRAGA, in botany, *saxifrage*, a genus of the Decandria Digynia class and order. Natural order of Succulentæ. Saxifragæ, Jussieu. Essential character: calyx five-parted, five-petalled, capsule two-beaked, one-celled, many-seeded. There are fifty species; of these we shall notice the S. granulata, or white saxifrage, which grows naturally in the meadows in many parts of England. The roots of this plant are like grains of corn, of a reddish colour without: there is a variety of this with double flowers, which is very ornamental. The leaves are tongue-shaped, gathered into heads, rounded at their points, and have cartilaginous and sawed borders. The stalk rises two feet and a half high, branching out near the ground, forming a natural pyramid to the top. The flowers have five white wedge-shaped petals, and ten stamina, placed circularly the length of the tube, terminated by roundish purple summits. When these plants are strong, they produce very large pyramids of flowers. S. umbrosa, commonly called London pride, or none-so-pretty, grows naturally on the Alps, and also in great plenty on a mountain of Ireland, called Mangerton, in the county of Kerry, in that island. The roots of this are perennial. S. oppositifolia grows naturally on the Alps, Pyrenees, and Helvetian mountains: it is also found pretty plentifully growing upon Ingleborough hill, in Yorkshire; Snowdon, in Wales, and some other places. It is a perennial plant, with stalks trailing upon the ground. The flowers are produced at the end of the branches, of a deep blue.

SCABIOSA, in botany, *scabious*, a genus of the Tetrandria Monogynia class and order. Natural order of Aggregatæ. Dipsaceæ, Jussieu. Essential character: calyx common, many-leaved, proper double superior, receptacle chaffy. There are forty-three species. S. arvensis, or meadow scabious, grows naturally in many places of Britain. The flowers are produced upon naked footstalks at the ends of the branches; they are of a purple colour, and have a faint odour. S. succisa, or devil's bit, grows in woods and moist places. This has a short tap-root, the end of which appears as if it was bitten or cut off, whence the plant has taken its name.

SCABRIDÆ, in botany, the name of the fifty-third order in Linnæus Fragments of a Natural Method, consisting of plants with rough leaves. Among these are the ficus and morus, which yield by incision a milky juice. Another genus is the cannabis, or hemp, from the leaves of which, in the East Indies, an intoxicating liquor is prepared, and from the seeds is drawn an oil useful for lamps.

SCÆVOLA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Campanulaceæ, Jussieu. Essential character: corolla one-petalled, with the tube cloven longitudinally, the border five-cleft and lateral; drupe inferior, containing one two-celled nut. There are three species, natives of the East Indies.

SCHÆFFERA, in botany, a genus of the Diœcia Tetrandria class and order. Essential character: male, calyx four or five-leaved; corolla four-petalled, or none: female, calyx four or five-parted; corolla four-parted, or none; berry two-celled;

seeds solitary. There are two species, viz. S. completa, and S. lateriflora, natives of the West Indies.

SCALE, a mathematical instrument, consisting of several lines drawn on wood, brass, silver, &c. and variously divided, according to the purposes it is intended to serve, whence it acquires various denominations, as the plain scale, diagonal scale, plotting scale, Gunter's scale, &c. See MATHEMATICAL INSTRUMENTS.

SCALE, *diagonal*, is projected thus: first draw eleven parallel lines at equal distances, the whole length of which being divided into a certain number of equal parts, according to the length of the scale, by perpendicular parallels, let the first division be again subdivided into ten equal parts, both above and below, then drawing the oblique lines from the first perpendicular below to the first subdivision above, and from the first subdivision below to the second subdivision above, &c. the first space shall thereby be exactly divided into one hundred equal parts; for as each of these subdivisions is one tenth part of the whole first space or division, so each parallel above it is one tenth of such subdivision, and consequently one hundredth part of the whole first space; and if there be ten of the larger divisions, one thousandth part of the whole scale. If therefore the larger divisions be accounted units, the first subdivisions will be tenth parts of an unit, and the second subdivisions, marked by the diagonals on the parallels, hundredth parts of an unit. Again, if the larger divisions be reckoned tens, the first subdivisions will be units, and the second subdivisions tenth parts: and if the larger divisions be accounted hundredths, the first subdivisions will be tens, and the second units: and so on.

SCALE, *Gunter's*, an instrument, so called from Mr. Gunter, its inventor, is generally made of box: there are two sorts, the long Gunter and the sliding Gunter, having both the same lines, but differently used, the former with the compasses, the latter by sliding. The lines now generally delineated on those instruments are the following, viz. a line of numbers, of sines, tangents, versed sines, sine of the rhumb, tangent of the rhumb, meridional parts, and equal parts; which are constructed after the following manner:

The line of numbers is no other than the logarithmic scale of proportionals, wherein the distance between each division is equal to the number of mean proportionals contained between the two terms, in such parts as the distance between 1 and 10 is 1000, &c. equal the logarithm of that number. Hence it follows, that if the number of equal parts expressed by the logarithm of any number be taken from the same scale of equal parts, and set off from 1 on the line of numbers, the division will represent the number answering to that logarithm. Thus, if you take .954, &c. (the logarithms of 9) of the same parts, and set it off from 1 towards 10, you will have the division standing against the number 9. In like manner, if you set off .903, &c. .845, &c. .778, &c. (the logarithms of 8, 7, 6) of the same equal parts from 1 towards 10, you will have the divisions answering to the numbers 8, 7, 6. After the same manner may the whole line be constructed.

The line of numbers being thus constructed, if the numbers answering to the natural sines and tangents of any arch, in such parts as the radius is 10,000, &c. be found upon the line of numbers, right against them will stand the respective divisions answering to the respective arches, or which is the same thing, if the distance between the centre and that division of the line of numbers, which expresses the number answering to the natural sine or tangent of any arch, be set off on its respective line from its centre towards the left hand, it will give the point answering to the sine or tangent of that arch: thus the natural sine of 30 degrees being 5,000, &c. if the distance between the centre of the line of numbers (which in this case is equal to 10,000, &c. equal the radius) and the division, on the same line representing 5000, &c. be set off from the centre, or 90 degrees, on the line of sines, towards the left hand, it will give the point answering to the sine of 30 degrees. And after the same manner may the whole line of sines, tangents, and versed sines be divided.

The line of sines, tangents, and versed sines being thus constructed, the line sine of the rhumb, and tangent of the rhumb are easily divided, for if the degrees and minutes answering to the angle which every rhumb makes with the meridian, be transferred from its respective line to that which is to be divided, we shall have the several points required: thus if the distance between the radius or centre, and sine of 45 degrees equals the fourth rhumb, be set off upon the line sine of the rhumb, we shall have the point answering to the sine of the

fourth rhumb; and after the same manner may both these lines be constructed. The line of meridional parts is constructed from the table of meridional parts, in the same manner as the line of numbers is from the logarithms.

The lines being thus constructed, all problems relating to arithmetic, trigonometry, and their depending sciences, may be solved by the extent of the compasses only; and, as all questions are reducible to proportions, the general rule is, to extend the compasses from the first term to the second, and the same extent of the compasses will reach from the third to the fourth; which fourth term must be so continued as to be the thing required, which a little practice will render easy.

Scale, *scala*, in music, is a denomination given to the arrangement of the six syllables invented by Guido Aretine, *ut*, *re*, *mi*, *fa*, *sol*, *la*, called also gamut. It bears the name scale (*q. d.* ladder) because it represents a kind of ladder, by means whereof, the voice rises to acute, or descends to grave; each of six syllables being, as it were, one step of the ladder. Scale is also used for a series of sounds rising or falling towards acuteness or gravity, from any given pitch of tune, to the greatest distance that is fit or practicable, through such intermediate degrees as make the succession most agreeable and perfect, and in which we have all the harmonical intervals most commodiously divided.

Scales *of fish*, generally possess a silvery whiteness, and are composed of different laminæ. In many of their properties they resemble horn. By long boiling in water they become soft, and when they are kept for some hours in nitric acid, they are converted into a transparent membranous substance. By saturating the acid with ammonia, a precipitate is formed, which is phosphate of lime. The constituent parts of scales, therefore, are membrane and phosphate of lime.

SCALENE, or Scalenous triangle, in geometry, a triangle whose sides and angles are unequal.

SCAMMONY, in the Materia Medica, is a concreted vegetable juice of a plant of the same name, partly of the resin and partly of the gum-kind, of which there are two sorts, distinguished by the names of the places from whence they are brought. The Aleppo scammony is of a spongy texture, light and friable; it is of a faint disagreeable smell, and its taste is bitterish, very nauseous, and acrimonious. The Smyrna scammony is considerably hard and heavy, of a black colour, and of a much stronger smell and taste than the former, otherwise it much resembles it.

SCANDALUM *magnatum*, is the special name of a statute, and also of a wrong done to any high personage of the land, as prelates, dukes, marquisses, earls, barons, and other nobles; and also the chancellor, treasurer, clerk of the privy seal, steward of the house, justice of one bench or other, and other great officers of the realm, by false news, or horrible, or false, messages, whereby debates and discord, between them and the commons, or any scandal to their persons might arise. 2 Richard II. c. 5. This statute has given name to a writ, granted to recover damages thereupon.

It is now clearly agreed, that though there be no express words in the statute which give an action, yet the party injured may maintain one on this principle of law, that when a statute prohibits the doing of a thing, which if done might be prejudicial to another, in such case he may have an action on that very statute for his damages.

SCANDIX, in botany, *chervil*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ or Umbelliferæ. Essential character: florets of the disc most commonly male; corolla radiate; petals emarginate; fruit awl-shaped. There are eleven species. The most remarkable is S. odorata with angular furrowed seeds. It is a native of Germany; and has a very thick perennial root, composed of many fibres, of a sweet aromatic taste, like aniseed, from which come forth many large leaves that branch out somewhat like those of fern, whence it is named sweet fern.

SCANNING, in poetry, the measuring of a verse by feet, in order to see whether or no the quantities be duly observed.

The term is chiefly used in regard to the Greek and Latin verses. Thus an hexameter verse is scanned, by resolving it into six feet; a pentameter, by resolving it into five feet, &c.

SCANTLING, in building, a measure, or standard by which the dimensions of things are to be determined. The term is particularly applied to the dimensions of any piece of timber, with regard to its breadth and thickness.

SCAPEMENT, a general term for the manner of communicating the impulse of the wheels to the pendulum of a clock.

Common scapements consist of the swing wheel and pallets only. See HOROLOGY, &c.

SCAPOLITE, in mineralogy, a species of the Flint genus, is of a greyish white colour, passing into greenish grey; it occurs massive, but most commonly crystallized in long, thin, often acicular prisms. Externally it is glistening; internally it is shining and glistening; its lustre is between resinous and pearly. It is brittle and frangible. Specific gravity about 3.7. Before the blowpipe it intumesces, and melts into shining white enamel. It is found in the iron-stone mines in Norway. Its crystals are sometimes mixed with mica, calc-spar, and felspar. It is composed of

Silica	48
Alumina	30
Lime	14
Oxide of iron	1
Water	2
	95
Loss	5
	100

SCARABÆUS, in natural history, the *beetle*, a genus of insects of the order Coleoptera. Generic character: antennæ clavate, the club lamellate; feelers four; foreshanks generally toothed. In this genus there are several hundred species, in four divisions, which are distinguished by the form of their feelers.

S. Hercules, or Hercules beetle, is the most remarkable species, as well in size as in beauty. It is five or six inches long; the wing-shells are of a smooth surface, of a bluish-grey colour, marked with round, deep-black spots of different sizes; from the upper part of the thorax proceeds a horn of great length, in proportion to the body; it is sharp at the tip, and is furnished throughout its whole length with a fine, short, velvet-like pile, of a brownish-orange colour; from the front of the head also proceeds a strong horn, like the other, but not furnished with any pile. This insect is found in several parts of South America, where great numbers are said to be sometimes seen on the mammee-tree, rasping off the rind of the slender branches, by working nimbly round them with the horns, till they cause the juice to flow, which they drink to intoxication, and in this state fall senseless from the tree. This fact has been controverted by the learned Fabricius.

In this country, the S. melolontha, or cock-chaffer, is very common. The larva inhabits ploughed lands, and feeding on the roots of corn; and the complete insect makes its appearance during the middle and the decline of summer. This insect sometimes appears in such prodigious numbers, as almost to strip the trees of their foliage, and to produce mischiefs nearly approaching to those of the locust-tribe; they are thus described in the "Philosophical Transactions" for the year 1697, by Mr. Molineux. These insects were first noticed in this kingdom in 1688. They appeared on the south-west coast of Galway, brought thither by a south-west wind, one of the most common, I might almost say, trade-winds, of this country. From hence they penetrated into the inland parts towards Heddford, about twelve miles north of the town of Galway: here and there in the adjacent country, multitudes of them appeared among the trees and hedges in the day-time, hanging by the boughs in clusters, like bees when they swarm. In this posture they continued, with little or no motion, during the heat of the sun; but, towards evening or sun-set, they would all disperse and fly about with a strange humming noise, like the beating of distant drums, and in such vast numbers, that they darkened the air for the space of two or three miles square. Persons travelling on the roads, or abroad in the fields, found it very uneasy to make their way through them, they would so beat and knock themselves against their faces in their flight, and with such a force as to make the place smart, and leave a slight mark behind them. In a short time after their coming, they had so entirely eat up and destroyed all the leaves of the trees for some miles round, that the whole country, though in the middle of summer, was left as bare as in the depth of winter; and the noise they made in gnawing the leaves, made a sound much resembling the sawing of timber. They also came into the gardens and destroyed the buds, blossoms, and leaves of all the fruit-trees so that they were left perfectly naked; nay many that were more delicate than the rest, lost their sap as well as leaves, and quite withered away, so that they never recovered again. Their multitudes spread so exceedingly, that they infested houses, and became extremely offensive and troublesome. Their numerous young, hatched from the eggs which they had lodged under ground, near the surface of the earth, did still more harm in that close retirement

than all the flying swarms of their parents had done abroad; for this destructive brood, lying under ground, eat up the roots of corn and grass, and thus consumed the support both of man and beast. This plague was happily checked several ways. High winds, and wet misling weather, destroyed many millions of them in a day; and when this constitution of the air prevailed, they were so enfeebled that they would let go their hold, and drop to the ground from the branches, and so little a fall as this was sufficient quite to disable, and sometimes perfectly kill them. Nay, it was observable, that even when they were most vigorous, a slight blow would for some time stun them, if not deprive them of life. During these unfavourable seasons of the weather, the swine and poultry of the country would watch under the trees for their falling, and feed and fatten upon them; and even the poorer sort of the country people, the country then labouring under a scarcity of provision, had a way of dressing them, and lived upon them as food. In a little time it was found, that smoke was another thing very offensive to them, and by burning heath, fern, &c. the gardens were secured, or if the insects had already entered, they were thus driven out again. Towards the latter end of summer, they returned of themselves, and so totally disappeared, that in a few days you could not see one left. A year or two ago, all along the south-west coast of the county of Galway, for some miles together, there were found dead on the shore such infinite multitudes of them, and in such vast heaps, that, by a moderate estimate, it was computed there could not be less than forty or fifty horse-loads in all; which was a new colony, or a supernumerary swarm, from the same place whence the first stock came, in 1688, driven by the wind from their native land, which I conclude to be Normandy, or Britany, in France, it being a country much infested with this insect, and from whence England heretofore has been pestered in a similar manner, with swarms of this vermin; but these, meeting with a contrary wind before they could land, were stopped, and, tired with the voyage, were all driven into the sea, which, by the motion of its waves and tides, cast their floating bodies in heaps on the shore. It is observed, that they seldom keep above a year together in a place, and their usual stages, or marches, are computed to be about six miles in a year. Hitherto their progress has been westerly, following the course of that wind which blows most commonly in this country."

The larva of this insect is eagerly sought after and devoured by swine, bats, crows, and poultry: it is said to be two or three years in passing from its first form into that of the perfect insect. The eggs are laid in small detached heaps, beneath the surface of some clod, and the young, when first hatched, are scarcely more than the eighth of an inch in length, gradually advancing in their growth, and occasionally shifting their skins, till they arrive at the length of nearly two inches. At this period they begin to prepare for their change into a chrysalis or pupa, selecting for the purpose some small clod of earth, in which they form a cavity, and after a certain time, divest themselves of their last skin, and immediately appear in the pupa state; in this they continue till the succeeding summer, when the beetle emerges from its retirement, and commits its depredations on the leaves of trees, breeds, and deposits its eggs in a favourable situation, after which its life is of very short duration. If the larva appear in autumn in considerable quantities, they are said to prognosticate epidemic disorders.

A species of great beauty is the S. auratus, or golden beetle, about the size of the common or black garden beetle; the colour is most brilliant, varnished, and of a golden-green. This is a fine object for the magnifying glass. It is not very uncommon during the hottest parts of summer, frequenting various plants and flowers; its larva is commonly found in the hollows of old trees, or among the loose dry soil at their roots, and sometimes in the earth of ant-hills.

Mr. Donovan has described, among his English insects, the S. stercorarius, or clock-beetle, which flies about in an evening, in a circular direction, with a loud buzzing noise, and is said to foretel a fine day. It was consecrated by the Egyptians to the sun; is infested with the acarus and ichneumon; the body is often coloured with a bluish or greenish gloss, sometimes brassy beneath; shells frequently dull, rufous.

SCARIFICATION, in surgery, the operation of making several incisions in the skin by means of lancets, or other instruments, particularly the cupping instrument.

SCARP, in fortification, is the interior talus, or slope of the ditch next the place, at the foot of the rampart.

SCARP, in heraldry, the scarf which mili-

tary commanders wear for ornament. It is borne somewhat like a battoon sinister, but is broader than it, and is continued out to the edges of the field; whereas the battoon is cut off at each end.

SCARUS, in natural history, a genus of fishes of the order Thoracici. Generic character: instead of teeth, strong bony processes, crenated at the edges; gill-membrane five-rayed; lateral line mostly branched. There are eight species; S. rivulatus, is found in the Red Sea, about the length of three feet. It feeds on herbs, and is used for food; but any puncture, or laceration, by the dorsal spine of this fish is said to be attended with extraordinary pain and inflammation. The other species are mostly inhabitants of the same sea.

SCAVAGE, a toll or custom anciently exacted by mayors, sheriffs, and bailiffs, of cities and towns-corporate, and of merchant-strangers, for wares exposed and offered to sale within their liberties; which was prohibited by 19 Henry VII. But the City of London still retains this custom.

SCENOGRAPHY, in perspective, the representation of a body on a perspective plane; or, a description thereof in all its dimensions, such as it appears to the eye. The ichnography of a building, &c. represents its plan, or ground-work; the orthography is a view of the front, or one of its sides; and the scenography is a view of the whole building, front, sides, height, and all, raised on the geometrical plan.

SCEPTRE, in astronomy, one of the six new constellations of the southern hemisphere consisting of seventeen stars.

SCHAALSTONE, in mineralogy, a species of the Calc genus, is of a greyish white colour, with varieties: it occurs massive, and the lustre of its principal fracture is shining and nearly pearly. It is translucent, brittle, easily frangible, and not very heavy. It has hitherto been found only in the Bannat of Temeswar, and is accompanied by ores of copper. It is composed of lime and silica.

SCHAUM *earth*, or FOAMING *earth*, in mineralogy, a species of the Calc genus, is of a very light yellowish, nearly silver white colour, approaching sometimes to greyish-white. It occurs massive and disseminated, sometimes loose and composed of fine scaly particles, or intermediate between friable and loose. Its lustre is between shining and glistening. It is soft, friable, fine, but not greasy. With acids it effervesces and is dissolved in them. By analysis it is found to be composed of lime and carbonic acid. It is nearly allied to slate-spar, and is found in the forest of Thuringia, also in the north of Ireland.

SCHEFFLERA, in botany, so named in honour of Scheffer, physician and botanist at Dantzic, a genus of the Pentandria Decagynia class and order. Essential character: calyx five-toothed; corolla five-petalled; capsule eight or ten celled; seeds solitary, semicircular. There is only one species, *viz.* S. digitata, a native of New Zealand.

SCHEME, a draught or representation of any astronomical or geometrical figure, or problem, by lines sensible to the eye; or of the celestial bodies in their proper places for any given moment. It is otherwise called a diagram.

SCHEUCHZERIA, in botany, so named in memory of John Scheuchzer, professor of physic at Zurich, a genus of the Hexandria Trigynia class and order. Natural order of Tripetaloideæ. Junci, Jussieu. Essential character: calyx six-parted; corolla none; styles none; capsule three, inflated, one-seeded. There is but one species, *viz.* S. palustris, a native of the North of Europe.

SCHIEFER *spar*, one of the species of carbonate of lime. It is of a grey colour, passing to red, and even in some specimens to green. It is found massive; the texture is foliated; it is brittle; feels unctuous; and may be scratched with the nail. Specific gravity 2.7. It is composed of carbonate of lime, with some silica, and oxide of iron.

SCHILLER *stone*, in mineralogy, a species of the Talc genus, of an olive green: usually disseminated and massive, probably also crystallized. Lustre shining, passing into semi-metallic: fracture perfectly foliate. Soft, slightly brittle, easily frangible, and not particularly heavy. It occurs imbedded in serpentine, and is frequently accompanied with mica. It is found in Saxony, Cornwall, and Scotland.

SCHINUS, in botany, a genus of the Dioecia Decandria class and order. Natural order of Dumosæ. Terebintaceæ, Jussieu. Essential character: calyx five-parted; petals five: female, berry three-celled. There are two species, *viz.* S. molle, Peruvian mastich tree, and S. areira, Brasilian mastich tree.

SCHISTUS, in mineralogy, a name given to several different kinds of stones, but more especially to some of the argillaceous kind: as, 1. The bluish purple schistus,

S. tegularis, or common roof-slate: this is so soft that it may be slightly scraped with the nail, and is of a very brittle lamellated texture: of the specific gravity of 2.8. It is fusible *per se* in a strong heat, and runs into a black scoria. By a chemical analysis it is found to consist of

Argillaceous earth	26
Silex	46
Magnesia	8
Lime	4
Iron	14
	98

The dark blue slate, or S. scriptorius, contains more magnesia and less iron than the common purple schistus, and effervesces more briskly with acids. Its specific gravity is 2.7. 2. The pyritaceous schistus is of a grey colour, brown, blue, or black; and capable of more or less decomposition by exposure to the air, according to the quantity of pyritous matter it contains, and the state of the iron in it. The aluminous schistus belongs to this species. 3. The bituminous schistus is generally black, and of a lamellated texture, of various degrees of hardness, not giving fire with steel, but emitting a strong smell when heated, and sometimes without being heated.

SCHMELZSTEIN, in mineralogy, a substance hitherto only found on the Pyrenees, where it is imbedded in steatite: it is of a greyish-white, passing through the different shades to rose red; it is shining, and its lustre is vitreous; it is easily frangible. Specific gravity 2.6. It swells before the blow-pipe. The constituent parts are

Silica	60
Alumina	24
Calcareous earth	10
Water	2
	96
Loss	4
	100

SCHMIDELIA, in botany, so named in honour of Casimir Christopher Schmidel, professor of botany at Erlang, a genus of the Octandria Digynia class and order. Natural order of Sapindi, Jussieu. Essential character: calyx two-leaved; corolla four-petalled; germs pedicelled, longer than the flower. There is only one species, viz. S. racemosa, a native of the East Indies.

SCHOENUS, in botany, *bog rush*, a genus of the Triandria Monogynia class and order. Natural order of Calamariæ. Cyperoideæ, Jussieu. Essential character: glumes chaffy, heaped, the outer ones barren; corolla none; seed one, roundish among the glumes. There are forty-one species.

SCHOEPFIA, in botany, so named in honour of Johan David Schoepf, a genus of the Pentandria Monogynia class and order. Natural order of Aggregatæ. Caprifolia, Jussieu. Essential character: calyx double, outer bifid, inferior, inner superior, quite entire; corolla bell-shaped; stigma capitate; drupe one-seeded. There is but one species, *viz.* S. Americana, a native of Santa Cruz and Montserrat.

SCHOLIAST, or COMMENTATOR, a grammarian, who writes scholia, that is, notes, glosses, &c. upon ancient authors, who have written in the learned languages. See the next article.

SCHOLIUM, a note, annotation, or remark, occasionally made on some passage, proposition, or the like. This term is much used in geometry, and other parts of mathematics, where, after demonstrating a proposition, it is customary to point out how it might be done some other way, or to give some advice, or precaution, in order to prevent mistakes, or add some particular use, or application thereof.

SCHORL, in mineralogy, a species of the Flint genus, which is divided by Werner into two sub-species, *viz.* the common schorl and the tourmaline. The common schorl is black. It occurs often massive and disseminated, seldom in rolled pieces, and frequently crystallized. The crystals are mostly acicular; fragments, when broken, indeterminably angular; it very rarely presents coarse and small grained distinct concretion; sometimes it occurs in very thin, and but rarely in thick straight and prismatic distinct concretions. It it opaque, and but little translucent on the edges, when it passes to the tourmaline. It gives a grey streak; is hard, and very easily frangible. Specific gravity from 3.09 to 3.21. It melts before the blow-pipe, without addition, into a blackish slag. Melted with borax, it forms a greenish coloured glass. It is composed of

Silica	33.33
Alumina	40.83
Iron	20.41
Manganese	3.33
	97.90
Loss	2.10
	100

By heating it exhibits positive electricity at one end, and negative at the other: as it cools, these electricities are reversed. It occurs in primitive rocks, chiefly in quartz and granite; with the former, it constitutes a peculiar mountain rock. It is found on many parts of the Continent, and in Scotland. It differs from tourmaline in colour, degree of lustre, fracture, transparency, and distinct concretions; also in geonostic situation; tourmaline occurs almost always imbedded, and in single crystals; but schorl is aggregated, and occurs in beds.

Tourmaline, called also electricus turmalin, is of a green or brown colour, passing into others even to the indigo blue. The colours are mostly dark. It occurs very seldom massive, oftener in rolled pieces, but most frequently crystallized. The crystals are generally three sided prisms; they are usually imbedded; the internal lustre is splendent and vitreous. It is hard and easily frangible. Specific gravity from 3.08 to 3.36. Before the blow-pipe it melts into a greyish-white vesicular enamel. It was found in Ceylon and the Brazils in the 16th century; and since that in Madagascar and Ava, in many parts of the European continent, and in Scotland. Two specimens have been analysed by Bergman and Vanquelin, the former was brought from Ceylon, the latter from Brazil.

	Tourmaline of Ceylon.	Of Brazil.
Silica	37.0	40.0
Alumina	39.0	39.0
Lime	15.0	3.84
Oxide of iron	9.0	12.50
——— manganese		2.00
	100.8	97.34
	Loss	2.66
		100

Tourmaline has been long celebrated for its electrical effects, which are exhibited by friction, and also by heating; but if it is made very hot, as beyond 200° of Fahrenheit, it is deprived of its electrical properties. The more transparent the tourmaline the stronger its electrical properties. It is sometimes cut and polished, and worn as a jewel; but on account of its want of transparency it is not very highly esteemed. The green coloured tourmaline has been described as the emerald; the blue, as the sapphire; and the crimson-red variety first found in Siberia, and since in Ava and Ceylon, has been called the daurite, siberite, and rubellite. Mr. Greville is in possession of the most magnificent specimen of the red variety, it is valued on account of its beauty and rarity at 1000*l*.

SCHOTIA, in botany, so named from Richard Vander Schot, a genus of the Decandria Monogynia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx five-cleft; petals five, inserted into the calyx, closed by the sides lying over each other; legume pedicelled. There is but one species, *viz.* S. speciosa, lentiscus-leaved schotia. It is a native of Senegal and the Cape of Good Hope.

SCHRADERA, in botany, so named in honour of Henr. Adolph. Schrader, a genus of the Hexandria Monogynia class and order. Essential character: calyx a superior rim, quite entire; corolla five or six-cleft; stigmas two; berry one-celled, many-seeded. There are two species, *viz.* S. capitata and S. cephalotes.

SCHREBERA, in botany, a genus of the Diandria Monogynia class and order. Essential character: calyx two-lipped; corolla from five to seven-cleft; capsule pear-shaped, two-celled, two-valved; seeds from eight to ten, membranaceous winged. There is but one species, *viz.* S. swietenioides.

SCHWALBEA, in botany, so named in honour of Schwalbe, a physician, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Schrophulariæ, Jussieu. Essential character: calyx four-cleft, the upper lobe very small; the lowest very large and emarginate. There is but one species, *viz.* S. Americana.

SCHWENKFELDIA, in botany, so named in memory of Caspar Schenckfelt, a Silesian physician, a genus of the Pentandria Monogynia class and order. Natural order of Rubiaceæ. Essential character: involucre four-leaved; corolla funnel-form; stigmas five; berry five-celled, many-seeded. There are three species.

SCHWENKIA, in botany, so named from Martin Welhelm Schwencke, professor of botany at the Hague, a genus of the Diandria Monogynia class and order. Natural order of Luridæ. Scrophulariæ, Jussieu. Essential character: corolla almost equal, with the throat plaited and glandular; stamens three, barren; capsule two-celled, many-seeded. There is only one species, *viz.* S. Americana, Guinea Schwenkia.

SCIÆNA, in natural history, a genus of

fishes of the order Thoracici. Generic character: head covered with scales; gill-membrane generally with about six rays; two dorsal fins placed in a furrow, into which they are often withdrawn. There are twenty nine species, the principal of which is the S. cirrosa or bearded-sciæna, which inhabits the European and American seas, and is from one to two feet in length. It was known to the ancients and esteemed by them for the table. It is of a pale yellow colour, striped longitudinally with dusky-blue. Its tail is slightly lunated, and it has under its chin a short fleshy beard.

SCIAGRAPHY, the profile or vertical section of a building used to show the inside of it. The same term is used in astronomy for the art of finding the hour of the day, or night, by the shadow of the sun, moon, stars, &c.

SCIENCE, in philosophy, denotes any doctrine deduced from self evident and certain principles, by a regular demonstration. Sciences may be properly divided as follows: 1. The knowledge of things, their constitutions, properties, and operations; this, in a little more enlarged sense of the word, may be called φυσικη, or natural philosophy; the end of which is speculative truth. 2. The skill of rightly applying these powers, πρακτικη; the most considerable under this head is ethics, which is the seeking out those rules and measures of human actions that lead to happiness, and the means to practise them; and the next is mechanics, or the application of the powers of natural agents to the uses of life. See PHILOSOPHY, *moral.* 3. The doctrine of signs, σημειωτικη; the most usual of which being words, it is aptly enough termed logic. See LOGIC.

This, says Mr. Locke, seems to be the most general, as well as natural, division of the objects of our understanding. For a man can employ his thoughts about nothing but either the contemplation of things themselves for the discovery of truth; or about the things in his own power, which are his actions, for the attainment of his own ends; or the signs the mind makes use of, both in the one and the other, and the right ordering of them for its clearer understanding. All which three, viz. things, as they are in themselves knowable; actions, as they depend on us in order to happiness; and the right use of signs, in order to knowledge, being *toto cælo* different, they seem to be the three great provinces of the intellectual world, wholly separate and distinct one from another.

SCILLA, in botany, *squill*, a genus of the Hexandria Monogynia class and order. Natural order of Coronariæ. Asphodeli, Jussieu. Essential character: corolla six-petalled, spreading, deciduous; filaments filiform. There are twenty-two species. The most remarkable is S. maritima or sea onion, whose roots are used in medicine. Of this there are two sorts, one with a red, and the other with a white root: which are supposed to be accidental varieties, but the white are generally preferred for medicinal use. The roots are large, somewhat oval-shaped, composed of many coats lying over each other like onions; and at the bottom come out several fibres. From the middle of the root rise several shining leaves, which continue green all the winter, and decay in the spring. Then the flower-stalk comes out, which rises two feet high, and is naked half-way, terminating in a pyramidal thyrse of flowers, which are white, composed of six petals, and spread open like the points of a star. This grows naturally on the sea-shores, and in the ditches where the salt water naturally flows with the tide, in most of the warm parts of Europe, so cannot be propagated in gardens; the frost in winter always destroying the roots, and for want of salt water they do not thrive in summer. The root is very nauseous to the taste, intensely bitter, and so acrimonious that it ulcerates the skin if much handled.

SCIOPTIC, or SCIOPTRIC *ball*, a sphere, or globe of wood, with a circular hole or perforation, wherein a lens is placed. It is so fitted that, like the eye of an animal, it may be turned round every way, to be used in making experiments of the darkened room.

SCIRPUS, in botany, *club rush*, a genus of the Triandria Monogynia class and order. Natural order of Calamariæ. Cyperoideæ, Jussieu. Essential character: glumes chaffy, imbricate every way: corolla none; seed one, beardless. There are sixty nine species.

SCIRE *facias*, is a judicial writ, and properly lies after a year and a day after judgment given; whereby the sheriff is commanded to summon or give notice to the defendant, that he appear and show cause why the plaintiff should not have execution. A scire facias, is deemed a judicial writ, and founded on some matter of record, as

judgment, recognizances, and letters patent, on which it lies to enforce the execution of them, or to vacate or set them aside; and if execution is not taken out within a year, it is necessary to revive the judgment by scire facias. But if execution has issued within that time, a further writ of execution may be had without a scire facias. This writ is so far in nature of an original, that the defendant may plead to it, and it is in that respect considered as an action. Wherefore a release of all actions, or a release of all executions, is a good bar to a scire facias.

SCIRRHUS, in surgery and medicine, a hard tumour of any part of the body, void of pain, arising from the inspissation and induration of the fluids contained in a gland, though it may appear in any other part, especially in the fat, being one of the ways wherein an inflammation terminates. See SURGERY.

SCITAMINEÆ, in botany, the name of the eighth order in Linnæus's Fragments of a Natural Method, consisting of beautiful exotic plants, some of which, as the banana, furnish exquisite fruits, and others have a fine aromatic scent; among these are the amomum or ginger; the canna, Indian flowering reed; and musa, the banana, or plantain tree. The plants of this order are all natives of very warm countries; they grow to great heights, but they are only perennial at the roots. Some of these plants are cultivated in high perfection at the botanical garden at Liverpool.

SCIURIS, in botany, a genus of the Diandria Monogynia class and order. Essential character: corolla unequal, with the upper lip trifid, the lower bifid and shorter; stamina five, but three barren, capsule five, united, one celled, one seeded. There is only one species, *viz.* S. aromatica, found in the wood of Guiana.

SCIURUS, the *squirrel*, in natural history, a genus of Mammalia, of the order Glires. Generic character: two fore-teeth in the upper-jaw wedge-formed, in the lower sharp; five grinders in each side of the upper-jaw, and four in each in the lower; clavicles in the skeleton; tail spreading towards each side; long whiskers. These animals live principally on seeds and fruits. They are extremely active and nimble, climbing trees with great rapidity, and bounding from one to another with a spring truly astonishing. Some are supplied with membranes, which enable them to extend this leap into something approximating to a short flight. Some are subterraneous, and others build in trees. They are sprightly, elegant, and interesting.

S. maximus, or the great squirrel, is the largest known species, being equal in size to a cat. It is found in the East Indies, where it pierces the cocoa for the sake of the liquor, to which it is extremely attached. It is easily tamed.

S. vulgaris, or the common squirrel, abounds almost throughout Europe, and in the temperate climates of Asia. Its length is about seven inches to the tail, which measures about eight. During the summer's day, it generally remains in its nest, appearing to be annoyed by the heat; but at night it is full of alertness and vivacity, and devoted to excursion and repast. It constructs its nest generally in the fork of two branches of trees, and with particular precaution, with respect to dryness, warmth, and cleanliness. The young are produced sometimes about the beginning of summer, in general, about the middle of it, and are three or four in number. Its food consists of various nuts and fruits, of which it stores considerable quantities for its winter consumption; it is fond also of certain species of fungi. In confinement it will take a vast variety of vegetable substances; but appears to prefer sugar to every other nourishment. See Mammalia, Plate XVIII. fig. 1.

S. cinereus, or the grey squirrel, is peculiar to North America, and is about the size of a half-grown rabbit. It resembles the former in its shape and manners. These animals have occasionally committed extreme ravages in some of the states of North America, in the cultivated lands; and to reduce their numbers, the legislature proclaimed a reward for their destruction. In the year 1750, a sum of no less than eight thousand pounds was distributed in premiums, to persons who had been engaged in killing them, and who must have destroyed between six and seven hundred thousand. It is not easily destroyed by the gun, on account of the perpetual versatility of its movements, and some of the best marksmen are often baffled by this extreme agility. It is easily familiarized, and appears susceptible of affection and gratitude to its benefactors.

The S. variegatus, or varied squirrel, is nearly twice the size of the last, and differs also in habits, as it resides in holes under the roots of trees, where it produces its young, and, like the rest of the genus, accumulates its stores. It is a native of Mexico.

S. striatus, or the striped squirrel, is met with in the north of Asia and America, is

subterraneous in its habitation, like the last, and is also addicted to hoarding, for winter, nuts and grain. It is distinguished, however, from every other species, by being provided with bags or pouches attached to its cheeks, in which, for the convenience of carriage, it can deposit large quantities of food, to take home with it after having swallowed a full meal. These squirrels abound in Siberia, amidst the woods of maple and fir, at the roots of which they make their burrows. They never mount trees, but when they have no other means of escape from an enemy, yet then they climb them with great celerity. They are very discriminating in their selection of food, and have been seen frequently to exchange cargoes contained in their pouches, for a species of food which they casually and unexpectedly met with, and which they happened to prefer to the former. They retain in captivity much of their native wildness, and appear to evince no feelings of regard to their protectors.

S. volans, or the common flying squirrel, is the only one of that description in Europe, and is found there only in the coldest climates. In the north of Asia it occurs more frequently. Its colour above is a white grey, and beneath a perfect white. It is about six inches in length to the tail. It resides generally in hollow trees near the top, is solitary in its habits, associating even in pairs only in the spring. It feeds principally on the catkins of the birch, and in winter secludes itself in its nest, occasionally quitting it in fine weather. By means of an expansile furry membrane reaching from the fore feet to the hind ones, these animals are enabled to spring or fly to the distance of thirty or forty yards. Climbing nearly to the top of one tree, it directs its movements always downwards, and by spreading this membrane as widely as possible, with its fore feet extremely distant from each other, presents such a surface to the air beneath as gives it considerable buoyancy, and converts its elastic bounds into a species of flight. The membrane is also highly serviceable in cherishing the young ones, which are produced usually in May, and about three at a birth. See Mammalia, Plate XVIII. fig. 4.

S. petaurista, or the sailing squirrel, is an inhabitant of Java and the Indian islands, and can spring to an immense distance from tree to tree, by means of a membrane similar to that of the preceding, which is extremely thin in the middle, and thicker towards the extremities. This is the largest of all the flying squirrels, and is eighteen inches long, exclusively of the tail. For the Barbary squirrel and the black squirrel see Mammalia, Plate XVIII. fig. 2. and 3.

SCLERANTHUS, in botany, *knawel*, a genus of the Decandria Digynia class and order. Natural order of Caryophillei Portulaceæ, Jussieu. Essential character: calyx one-leafed, inferior; corolla none; seeds two inclosed in the calyx. There are three species.

SCLERIA, in botany, a genus of the Monoecia Triandria class and order. Essential character: male, calyx glume from two to six-valved, many-flowered, awnless: female, calyx from two to six-valved, one-flowered, awnless; stigmas one to three; seed nut subglobular, somewhat boney, coloured. There are nine species.

SCLEROCARPUS, in botany, a genus of the Syngenesia Polygamia Frustranea class and order. Natural order of Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx six-leaved, three exterior larger, like the leaves, three interior smaller, like scales, alternate; pappus none; receptacle chaffy. There is only one species, *viz.* S. Africanus, a native of the Cape of Good Hope.

SCLEROTICA, in anatomy, one of the tunics, or coats of the eye; it is hard, opaque, and extended from the cornea to the optic nerve; its forepart is transparent, and called the cornea.

SCOLEX, in natural history, a genus of the Vermes Intestina class and order: body gelatinous, variously shaped, broadish on the fore-part and pointed behind; sometimes linear and long, sometimes wrinkled and short, round, flexuous, or depressed; head protrusile and retractile. Two species only are mentioned, *viz.* the pleuronectidis and lophii; the former is found in the intestinal mucus of the turbot, sole, plaise, gwiniard, and the lump fish, seldom visible to the naked eye. The other, as its name denotes, is discovered in the intestinal mucus of the lophius piscatorius: the body is minute, and hardly visible to the naked eye.

SCOLIA, in natural history, a genus of insects of the order Hymenoptera: mouth with a curved sharp mandible, crenate within: jaw compressed, projecting, entire and horny; tongue inflected, trifid, very short; lip projecting, membranaceous at the tip and entire; four feelers equal and fili-

form, in the middle of the lip; antennæ thick, filiform, the first joint longer. There are about twenty species.

SCOLOPAX, the *curlew*, in natural history, a genus of birds of the order Grallæ. Generic character: the bill long and incurvated; face covered with feathers; nostrils linear and longitudinal, near the base; tongue short and sharp-pointed; toes connected by a membrane to the first point. There are fifty species, of which the following are the chief: S. arquata, or the common curlew, is generally about two feet long, and is to be met with in England throughout the year, either on the coasts or near the mountains. Slugs and worms, which its bill extracts from the ground in the morning and the evening, constitute its inland subsistence; and when on the shores of the sea it feeds on marine animals. These birds are often observed in large flocks, and are used by many for food. Those killed on the coasts, however, are rank and fishy.

S. rusticola, or the woodcock. These birds are about fourteen inches in length. They are migratory in this country, and supposed to proceed from Sweden. They arrive about the beginning of October, but have never been observed on their first reaching land, and are supposed always to effect this by night or in misty weather. When first seen they are extremely weak and exhausted, and have sometimes scarcely retained strength enough to fly to a very short distance, having been destroyed in numbers by a stick only. Before the rigours of winter set in, they reside in moory and mountainous districts; but in the extreme cold they change their haunts for such as are lower and warmer, and frequent particularly warm springs in glens and dells, covered with sheltering trees and brushwood. They occasionally breed in this country, some few instances of this having been unquestionably authenticated; but, with such very extraordinary exceptions, woodcocks collect together about the middle of March to return to their native country. They are often, however, like other voyagers detained by unfavourable winds, and in such circumstances sportsmen find them in considerable numbers, and destroy them with unmerciful eagerness. The woodcock is more remarkable for stupidity than intelligence, and is easily taken in traps and sprynges, which are placed for it near tepid springs, in passages artificially managed, as this bird never attempts to overcome obstacles in its way, even by leaping only off a small stone. It is, from this indolent tendency, decoyed into the direction which, however smooth and pleasant at first, terminates in ruin. Its flesh is highly valued, but is considered as affording its full relish, only when the bird is dressed entirely undrawn, in which state with more epicurism than delicacy, it is generally eaten. See Aves, Plate XIII. fig. 5.

S. gallinago, or the snipe, weighs about four ounces, is about twelve inches long, and to be found in nearly every country of the world. Its food consists of worms and insects, which it seeks near small streamlets, and in general in wet grounds. It eats also slugs. It is a bird of extreme caution and vigilance, and the sight of the sportsman or the dog impels it to immediate concealment amidst the dry herbage of its haunts, from which the resemblance of colour renders it almost impossible to discriminate it. On the approach of the enemy it bursts from its shelter with such uncommon variety of direction and velocity of motion, as renders its destruction by the gun one of the greatest atchievements of the sportsman's art. Snipes are sometimes approached nearly, by the accurate imitation of their sounds and shot upon the ground, and they are often taken by snares, like the woodcock. The flavour and the preparation of them are also similar. They are in this country migratory, but cases have occurred of their breeding in it.

S. ægocephalus, or the common godwit, is of the weight of twelve ounces, and ranks in the highest order of delicacies. It is found in almost every country, and in the marshy grounds of Lincolnshire and Cambridgeshire is particularly abundant, feeding on insects and small worms, but approaches the sea shore on the advance of the rigours of winter. These birds, in several parts of the country, are caught in nets, into which they are deluded by representations of birds of their own species, made of wood and painted with some correctness of resemblance. After they are taken they are by some fattened for sale with great facility and success.

S. calidris, or redshank, is not uncommon in this island, and particularly towards the south. It breeds in the marshes, and is remarkable for flying in a direction completely irregular round its nest, by which it is very frequently discovered. Its length is twelve inches. For the redshank see Aves, Plate XIII. fig. 6.

SCOLOPENDRA, in natural history, *centipede*, a genus of insects of the order Aptera. Antennæ setaceous; two feelers filiform, united between the jaws; lip toothed and cleft; body long, depressed, consisting of numerous transverse segments: legs numerous, as many on each side as there are segments of the body. There are thirteen species, found in almost all parts of the world; they live in decayed wood, or under stones, and some of them in fresh and salt water: they prey on other insects. The larger species are found only in the hotter regions of the globe; they are insects of a terrific appearance, and possess the power of inflicting severe pain and inflammation by their bite.

S. morsitans is a native of Asia, Africa, and South America. It is eight or ten inches long, of a yellowish brown; the head is armed on each side with a very large curved fang, of a strong or horny nature; these fangs are furnished on the inside, near the tip, with an oblong slit, through which, during the act of wounding, an acrimonous or poisonous fluid, is discharged: the eyes are numerous on each side the head, and are placed in a small oval groupe; it has twenty legs on each side the body.

S. electrica has seventy legs on each side; its body is linear; it inhabits many parts of Europe, in decayed wood, and shines in the dark; the body is very flat and tawny, with a black line down the back. The motions of this insect are tortuous and undulatory, seldom continuing long in the same direction. It is possessed of a high degree of phosphoric splendor, which, however, seems to be only exerted when the animal is pressed or suddenly disturbed, when it diffuses a beautiful light, so powerful as not to be obliterated by that of two candles on the same table. It is very tenacious of life, and will endure long in the closest confinement without food.

S. forficata is a very common insect found frequently under stones and flower pots; it has a very swift motion, and is furnished with fifteen legs on each side; it is of a chesnut colour, and is about an inch and a half long.

SCOLOPIA, in botany, a genus of the Icosandria Monogynia class and order. Essential character: calyx inferior, three or four-parted; corolla three or four-petalled; berry crowned with the style, one-celled, six-seeded; seeds arilled. There is only one species, *viz.* S. pusilla, a native of Ceylon, where it is called khatu kurundu, or thorny cinnamon.

SCOLOSANTHUS, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Luridæ. Rubiaceæ, Jussieu. Essential character: calyx four-cleft; corolla tubular, with a revolute border; drupe one-seeded. There is but one species, *viz.* S. versicolor; this small shrub was discovered in the island of Santa Cruz, by Ryan.

SCOLYMUS, in botany, *golden thistle*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semiflosculosæ. Cichoraceæ, Jussieu. Essential character: calyx imbricate, spiny; pappus none; receptacle chaffy. There are three species, natives of the South of Europe.

SCOMBER, the *mackarel*, in natural history, a genus of fishes of the order Thoracici. Generic character: head compressed, smooth; gill membrane with seven rays; body smooth, oblong; lateral line carinate behind; small fins, generally, both above and below, near the tail. There are twenty-one species, of which we shall notice the following:

S. scomber, or the common mackarel. This is one of the most beautiful of fishes, and inhabits both the European and American seas. It is said by many to reside in winter near the North Pole, and as the spring advances, to move in immense shoals in a southerly direction, traversing a vast space in a short period, and proceeding nearly in a similar line of movement with that attributed to the herring, from the same extremities of the north. Some of the most eminent naturalists, however, have entertained doubts of these extensive voyages in both cases, and it is imagined by such that these fishes take up their residence during the rigour of winter, in the muddy or gravelly bottoms near the coasts where they abound so numerously in the spring. Shaw relates, that M. Pleville de Peley saw the bottoms near the coasts of Hudson's Bay, for a long space together, bristled with the tails of mackarel, all their other parts being imbedded in the gravel or mud. The mackarel is a fish highly admired, both for its beauty and excellence, and has in every age attracted particular notice and partiality from both these circumstances. The Romans prepared from it a condiment or essence for the table, which was in the highest estimation. The general length of this fish is fifteen inches, but specimens far larger have been occasionally met with.

S. thynnus, or the tunny, is sometimes

ten feet long, and on the Scotch coast one was taken which weighed four hundred and sixty pounds. In the Indian ocean it is said to exceed even this enormous size. It is recorded by Pliny, who was sufficiently attached to the marvellous, that the fleet of Alexander met with no slight obstruction from a host of tunnies, which it required considerable manœuvering to break through. These fishes are not particularly admired for food in this country, in which, indeed, they are rarely seen, approaching the British coast only in straggling parties, or rather as solitary individuals. By the ancients, fisheries were established for taking and preserving them on the coasts of the Mediterranean, in which sea they particularly abound, and there are at present on the same coasts very extensive establishments for this purpose. Indeed to the inhabitants on those shores the movements of tunny are watched and expected with as much eagerness as those of the herring or mackarel, in the north. The small fishes are generally carried fresh to market, and the large ones are cut up into pieces of a particular size, and preserved in salt in barrels. The tunny is a very voracious fish, and a great persecutor of the common mackarel.

SCONCE, in fortification, a small field-fort, built for the defence of some pass.

SCOPARIA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Personatæ. Scrophularia, Jussieu. Essential character: calyx four-parted; corolla four-parted, wheel-shaped; capsule one-celled, two valved, many-seeded. There are three species.

SCOPOLIA, in botany, so named in honour of Giovanni Antonio Scopoli, professor of chemistry and botany at Pavia, a genus of the Pentandria Monogynia class and order. Essential character: calyx five-cleft; nectary none; stigma capitate; capsule berried, five-celled; seeds solitary. There are two species, viz. S. aculeata and S. inermis.

SCOPUS, the *umbre*, in natural history, a genus of birds of the order Grallæ. Generic character: bill long, thick, compressed, a little hooked; nostrils linear, oblique; feet four-toed, cleft. The only species, the umbretta, or tufted umbre, is about as large as a crow, and twenty inches in length; its bill three inches and a half long; its body of a uniform brown colour, whence it derives its name. It is supposed to be a native of the Cape of Good Hope, but no circumstances of interest have been detailed by travellers of its residence, habits, and manners.

SCORPÆNA, in natural history, a genus of fishes of the order Thoracici. Generic character: the head large, aculeated, cirrhose, obtuse, without scales; somewhat compressed; eyes near each other; teeth in the jaws, palate, and throat; gill membrane, seven rayed; body thick and fleshy; dorsal fin single, long, with the rays of the fore part spinous. There are nine species enumerated by Gmelin, and fourteen by Shaw. We shall notice only the following:

S. porcus, or the porcine scorpæna, is about fourteen inches long, and an inhabitant of various parts of the Mediterranean, in considerable numbers. It lies near the shores under the stones, apparently in ambush for its prey, which consists particularly of small fishes and sea insects. It eats also sea weeds. The rays of its dorsal fin are furnished with strong spines, with which it often inflicts painful, if not dangerous wounds.

S. horrida, is found in the Indian seas, and is about thirteen inches long. The head and body, the pectoral and the dorsal fins, are covered with numerous abrupt cirri or beards; all the fins are supplied, on the fore part, with strong rays, and those of the dorsal extend almost completely along the back. In various other particulars of its form it is singularly uncouth, and altogether presents one of the most repulsive objects which can meet the eye.

SCORPIO, in natural history, a genus of insects of the order Aptera. Generic character: eight legs, besides two claspers, or hands, seated on the fore-part of the head; eight eyes, three placed on each side of the thorax, and two on the back; two feelers projecting cheliform; the lip is bifid, and the tail long, jointed, and terminated by a sharp, crooked sting; on the underside, between the breast and abdomen, are two instruments resembling a comb. There are ten species, all of which are armed with a slightly pungent sting; and in hot climates some of them are highly dangerous: they prey upon worms, spiders, flies, &c. and even on one another. S. afer, or great African scorpion, is the largest and by far the most formidable of the whole genus: it is held in great dread by the inhabitants: its poison is evacuated through two very small oblong foramina, situated on each side the

tip of the sting. Scorpions are viviparous insects, producing a very considerable number of young at once: these are at first entirely white, but acquire their dusky colour in the space of a few days: they are observed to cast their skin from time to time, in the manner of spiders: the larva and pupa are eight-footed, nimble, and resembling the perfect insect.

SCORPION, *scorpio*, in astronomy, the eighth sign of the zodiac, denoted by the character ♏. The stars in the constellation scorpio, in Ptolemy's catalogue, are 20; in Tycho's 10; and in Mr. Flamsteed's 49.

SCORPION, in the ancient art of war, an engine chiefly used in the defence of the walls of fortified places, by throwing arrows, fire-balls, or great stones.

SCORPIURUS, in botany, *caterpillar*, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: legume divided by isthmuses, or transverse partitions, revolute cylindrical. There are four species, all natives of the south of Europe.

SCORSONERA, in botany, *viper's grass*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semiflosculosæ. Cichoraceæ, Jussieu. Essential character: calyx imbricate with scales, scariose at the edge; pappus feathered, sessile; receptacle naked. There are nineteen species.

SCOT, a customary contribution laid upon all subjects according to their abilities. Whoever were assessed to any contribution, though not by equal portions, were said to pay scot and lot.

SCOTLAND. By 5 Anne, c. 8, the union of England and Scotland was effected, and the twenty-five articles of union, agreed to by the parliaments of both nations, were ratified and confirmed as follows: viz. the succession to the monarchy of Great Britain shall be the same as was before settled with regard to that of England. The united kingdoms shall be represented by one parliament. There shall be a communication of all rights and privileges between the subjects of both kingdoms, except where it is otherwise agreed. When England raises 2,000,000*l.* by land-tax, Scotland shall raise 48,000*l.* The standards of the coin, of weights, and measures, shall be reduced to those of England throughout the united kingdoms. The laws relating to trade, customs, and the excise, shall be the same in Scotland as in England. But all the other laws of Scotland shall remain in force, though alterable by the Parliament of Great Britain; and, particularly, laws relating to public policy are alterable at the discretion of Parliament. Laws relating to private right are not to be altered, but for the evident utility of the people of Scotland. Sixteen peers are to be chosen to represent the peerage of Scotland in Parliament, and forty-five members to sit in the House of Commons. The sixteen peers of Scotland shall have all privileges of Parliament, and all peers of Scotland shall be peers of Great Britain, ranking next after those of the same degree at the time of the union, and shall have all privileges of peers, except sitting in the House of Lords, and voting on the trial of a peer.

It was formerly resolved by the House of Lords, that a peer of Scotland, claiming and having a right to sit in the British House of Peers, had no right to vote in the election of the sixteen Scotch peers; and that if any of the sixteen Scotch peers are created peers of Great Britain, they thereby cease to sit as representatives of the Scotch peerage, and new Scotch peers must be elected in their room.

SCOTOGRAPH, an instrument to enable a person to write in the dark, invented by Mr. John Isaac Hawkins, and included in a patent taken out by him in 1803 for several other inventions relating to the graphic art.

Plate Scotograph explains the construction of this instrument. Fig. 1 is a plan of it; fig. 2, 3, and 4, parts; and fig. 5, a perspective view of the whole put together. A B D E is a small box, covered with morocco leather, to be carried in the pocket: its lid, F G, is made in two pieces, joined together by hinges in the middle, so as to turn back, as shown in fig. 5, and is kept shut by a small spring catch. *a a*, (fig. 1) is a small brass shelf, fixed along one side of the box, at about one-half of its depth from the bottom, it is also seen in the end section (fig. 4.) *b d e f*, is a small pentagraph made of brass; one end of the rod, *b*, is jointed to a small hinge, *g*, by which its motion allows the whole pentagraph to be lifted up; the other end of the rod, *b*, is jointed to the rod *f*, and the small handle, *h*, or pencil, which the writer holds in his hand when in use, is attached to the other end by an universal joint, which allows it to move in any direction, to imitate as much as possible the motion of a pen; *e* and *d* are the other two bars, completing the pentagraph: *i* is the

point which forms the letters; is screwed into the bar *d*: F G is a piece of wood glued to the bottom of the box, with a small piece of ivory fastened upon the top of it, to support the paper while it is written upon: the surface of this ivory is about the same height as the brass shelf, *a a*, as is seen in the section fig. 4: H and I are two small rollers, (one of which is shown separately in fig. 2) on which the paper is rolled; it is fastened to them at both ends, by a small brass lever, *k*, (fig. 2) which shuts down in a groove made in the roller: when the paper is put under this lever, and shut down, it is held fast, and by turning the roll is wound upon it: *l m* are two small milled heads, one on each roll, to turn them: at one end of the roll, I, a small rachet wheel, *t*, of six teeth, is fixed; it is turned round by a click, *k*, (fig. 4) jointed to a small lever, *l*, which is thrown up by a spring, *m*: *n* (fig. 1) is a piece of brass plate screwed to the side of the box: it is shown separately in fig. 3, and has two branches, to receive the pivots of the two rollers, H I; these arms are elastic, and press against the ends of the rollers, and causes them to turn rather stiffly, so that they will not be liable to be moved by the elasticity of the paper which is rolled upon them. The pentagraph is of the common kind: the three points, *g i*, and the end of *h*, being all in one line, as explained in the article PENTAGRAPH: the point *i*, which forms the letters, is a short piece of silver wire, screwed into the bar *d*, and pointed at the end to make this mark: the paper is rubbed over with whiting, or chalk; and when at any time the point is worn away, it may be renewed by screwing it through the bar a little further: the point is always made to project so far, that when the blunt point at the end of the pencil, *h*, rests upon the brass shelf, *a a*, the pentagraph will be set a little upon the strain, and by that means press' upon the paper with a proper degree of force to write legibly. In using the machine, the lid, F G, is to be half shut, as shown in fig. 5, and thus form a support for the hand while writing; the pencil, *h*, is held in the hand, and pressed down to touch the brass shelf, *a a*, and used in the same manner as a common pen or pencil, taking care to always begin at the end of the shelf; the side of the box, and a small ledge upon the edge of the shelf, limits the height of the letters. When the pencil arrives at the end of the shelf, it is to be brought back again, and the end of it is to be placed upon the end of the lever, *l*, and forced down the click, *k*, then takes into one of the teeth of the wheel, *t*, and turns it round one tooth; the pressure is then to be removed, and the spring, *m*, lifts up the lever, *l*, just the proper height to catch the next tooth of the wheel, as is shown in fig. 4: this operation moves the paper forward just the proper space to write another line. One of the uses of the pentagraph is to reduce the writing to half the size that it is made on the brass shelf, whereby double the number of lines are contained on a slip of paper that would be if written the full size, and the lines are but half the length, so that room is left at the ends of the rollers for the rachet wheel and milled nuts. The rollers will hold a slip of thin paper twenty inches long, and contain 100 lines, each of two inches long: this will contain a considerable quantity of information, and when it is all written, and rolled upon the roll, I, the lever, *k*, (fig. 2) of the other roller will be exposed to view; then the pentagraph is to be lifted up upon its hinge, *g*, and the lever raised up by putting the nail under the end of it: this releases one end of the paper; and by pulling it the other roll will be unwound; and when the small lever of that roller is taken up, the paper will be quite loose: another piece will be fixed with equal ease, by first fixing it to the roll H, and rolling it upon it, and then fastening it to the other. If at any time any particular line of the writing is wanted, it will be easily brought into view, by turning the rollers by their nuts, *l*, *m*.

This instrument would be particularly useful to persons who have occasion to make memorandums while on horseback, or travelling in a coach, as any degree of pressure may be given upon the brass shelf while writing, so as to avoid being disturbed by the most violent shocks, which cannot be done upon common paper for fear of breaking the pencil point, or of piercing the paper by it. Its use to blind people who have learned to write is very obvious.

SCRATCH, in the language of the salt-workers of our country, the name of a calcareous, earthy, or stony substance, which separates from sea-water in boiling it for salt. This forms a thick crust, in a few days, on the sides and bottoms of the pans, which they are forced to be at the pains of taking off once in a week, or ten days, otherwise the pans burn away and are destroyed.

SCREW, one of the five mechanical powers. See MECHANICS.

SCRIBING, in joinery, &c. is a term used when one side of a piece of stuff is to be fitted to another that is irregular. In order to make these join close all the way, they scribe it; that is, they lay the piece to be scribed close to the other they intend to scribe it to, and opening their compasses to the widest distance these two pieces stand from each other, they bear the point of one of the legs against the side they intend to scribe to, and with the other point draw a line on the stuff to be scribed. Thus they form a line on the irregular piece parallel to the edge of the regular one; and if the stuff be cut exactly to the line, when these pieces are put together they will seem a joint.

SCROPHULARIA, in botany, *figwort*, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: calix five-cleft; corolla subglobular, resupine; capsule two celled. There are twenty-two species.

SCROTUM. See ANATOMY.

SCROWLS, or SCROLLS, in architecture, the same with volutes.

SCRUPLE, a weight equal to the third part of a dram, or to twenty grains. Among goldsmiths it is equal to twenty-four grains.

SCUDDING, in naval affairs, is the movement by which a ship is carried precipitately before a tempest, and is either performed with a sail extended on her foremast; or, if the storm is excessive, without any sail, which is then called scudding under bare poles. In sloops and schooners, and other small vessels, the sail employed for this purpose is called the square-sail. In larger ships it is the fore-sail.

SCULPTURE. It is beyond human research to ascertain when this art was first practised, and by what nation. We may, however, safely conjecture that it was almost one of the original propensities of man, and may be said to have been born with him in every climate. This will still appear in the ardent and irresistible impluse of youth to make representations of objects in wood, and the attempts of savages to embody their conceptions of their idols. If a command from the Author of our being was necessary to prevent the ancient Israelites from making graven images, it may be naturally inferred that the inhabitants of the rest of the earth possessed similar propensities. The descriptions of the scriptures demonstrate that the art had been brought to great perfection at the period of which they treat; but they could not be so particular as to enable us to judge whether their excellence approached the remains we possess derived from other sources.

To proceed methodically on this subject, it becomes necessary to make a distinction between carving and sculpture; the former belonging exclusively to wood, and the latter to stone. It is extremely probable that every essay at imitating animated objects was in each nation made in wood originally, and it is vain to suppose the tools were any other at first than the sharp edges of broken stones or flints; a visit to the British Museum will afford the curious spectator a competent idea of what the nearest descendants of Adam accomplished in the art of carving with instruments of the above description in the figures of the South sea idols. The least enlightened nations possess individuals of superior observation, who see the defects of their neighbours, and by instruction or ridicule produce an attempt at reformation: this has evidently been the case amongst the Egyptians and Greeks, who of all the people of antiquity made the earliest and greatest progress in the art of sculpture. If the former commenced their imitation of nature in wood, it is probable they soon discovered that it was incapable of a durability commensurate with their wishes, they therefore adopted a close grained and beautiful granite, which not only required tools of iron, but those of the most perfectly tempered steel, to cut it; and with such they have left us at this very distant time vast numbers of excavated figures, as complete and as little injured as if executed within our own memory.

In examining the various sculptures of the Egyptians, we find that a general character prevails throughout their outlines, which demonstrate that the sculptors were natives of Egypt, and that they rigidly copied the expression and character of their countrymen. Had the persons employed in decorating the numerous magnificent works, the ruins of which still surprise the spectator, been invited from other countries, a variation of style in the drawing would have been readily discovered. The circumstance of their figures, both male and female, strongly resembling each other in every instance, proves that this people were not deficient in genius; and their spirited imitations of animals adds to our conviction, that had nature been more kind to the Egyptian in their forms and features, their sculptors were fully competent to give an accurate repre-

sentation of personal grace. Their limited and absurd ideas of religion were a decided bar to improvement, and led them to debase rather than improve the human form; hence we sometimes find the heads of animals attached to the bodies of men, and the ridiculous imputed acts of their idols are represented in strange unnatural positions, and those frequently repeated; hence the idea of grouping their figures was decidedly banished, except in a few cases, when the same outline occurs to the depth of four and five persons, each performing the same act, with the uniformity of a set of recruits, under the care of a drilling serjeant.

The errors of the Egyptians on this head cannot be more forcibly illustrated than by mentioning their manner of expressing a general punishment; a gigantic figure wields a weapon with one hand, and with the other grasps the hair of a group of kneeling figures, placed in a circle, with three ranges of heads appearing above each other, the hands, knees, bodies, and profiles exactly parallel. A second mistake in their sculpture was the disproportion of their figures to the object decorated with them, as it frequently happens that the same building contains hieroglyphics not three inches in length, which in another part of the structure are extended to several feet; indeed, all their productions in this art were a compound of littleness and vastness. Thus the temple of Apollinopolis Magna, at Etfu, has its side covered with figures half the height of the building, and the front with others not a sixth part of their size.

Very few of the detached figures or statues sculptured by the Egyptians deserve notice, otherwise than as objects of curiosity; indeed to examine them critically would be mere waste of time, as they are too frequently wilfully distorted to suit mythological conceptions: it is therefore impossible to select a subject deserving of examination, by which to judge of their skill in delineating the swells of the muscles in various positions. Denon has given several valuable specimens of their remains, amongst which are a species of caryatides, or naked figures, standing erect with their arms crossed on their breasts: these, however, are very little calculated to raise our opinion of the merit of the artists who made them; and, indeed, the only instances we recollect of correctness and propriety, are the sphinx, and the enormous clenched hand, now in the British Museum. Of the former, Denon speaks with enthusiasm: "I had only time to view the sphinx, which deserves to be drawn with a more scrupulous attention than has ever yet been bestowed upon it. Though its proportions are colossal, the outline is pure and graceful; the expression of the head is mild, gracious, and tranquil; the character is African; but the mouth, the lips of which are thick, has a softness and delicacy of execution truly admirable; it seems real life and flesh. Art must have been at a high pitch when this monument was executed; for, if the head wants what is called style, that is to say, the straight and bold lines which give expression to the figures under which the Greeks have designated their deities, yet sufficient justice has been rendered to the fine simplicity and character of nature which is displayed in this figure."

These observations corroborate what we have already advanced of the capability of the Egyptians to execute had their conceptions been equally correct; but as those were limited, their genius for excellent sculpture can only be collected from detached objects, where a ray has accidently emanated, and meeting with apathy from the public, perhaps another has never been excited in the mind of the artist; hence it is that we must look for elegance in their representations of animals, foliage, and flowers, which being admired by all, and not subject to the changes and varieties exhibited in the human frame and countenance, are more readily copied. In this part of our pursuit we are again assisted by Denon, who has presented us with many traces of simplicity in the capitals of their pillars, some of which are of about the same degree of excellence with the best specimens of Saxon sculpture, and in some cases strongly remind us of the works of that people; and it may be worthy of observation, that the shape of the Egyptian capital differs very little from those invented by the Greeks: one in particular might be supposed to be the work of the latter, as it is surrounded by a range of beautiful full-grown leaves of the palm, disposed as the acanthus leaf afterwards was; another formed of a collection of palm stalks, before the branches and leaves are fully developed, shows that a very little taste, added to the disposition, would have raised the reputation of Egyptian sculpture to a level with that of their more polished imitators, as there can be no doubt that they have afforded hints to the Greeks. The frieze of the great temple at Tentyra, also shows that the ideas of the Egyptians,

when confined to objects intended merely for ornament, approached very near perfection; in this instance, the sculptures of the wings of birds, variously and tastefully disposed, deserve the approbation of the enlightened observer.

We must now turn our attention to the acknowledged masters of the sublime art of sculpture, the ancient Greeks, to whom every nation of the earth still pays willing homage, and from whose matchless works each sculptor is happy to concentrate and improve his observations on the human figure, presented by them to his contemplation in its most graceful perfection. Such, indeed, has been the excellence and correctness of their imitations of nature, and the refined elegance of their taste, that many ages have elapsed, not one of which have afforded a single instance of improvement, even in the disposition of their scrolls, or other fanciful ornaments.

As modelling figures in earth has been a practice for ages, previous to their sculpture in stone, it may be supposed that this was the original method of making isolated resemblances of men; indeed, the facility with which alterations and improvements might be accomplished, seems to point out the propriety of using that material before the art of cutting stone was invented. Calisthenes, who was an Athenian, made a number of models, with which he adorned his residence; but it is of the sculptor,and not the modeller, that we are to treat at present. Of the latter, we might mention a very considerable number, whose names have reached us with their works, were they necessary, and yet compared with the statues distributed in every part of Europe, they are a very inconsiderable portion of the eminent men who have flourished in the different states of Greece. When we contemplate the beautiful specimens of their consummate art, we are at a loss which most to admire, the softness and delicacy given to the marble, or the exquisite skill demonstrated in every feature and muscle, which could only have been acquired by the most attentive observation of living subjects placed in each natural and easy attitude. Had not the people generally admired and respected the arts, so great a degrees of perfection would never have been attained, for the operation of producing a fine figure requires a mind at ease, and the means of subsistence beyond the mere wants of the day; it is therefore extremely probable that those who employed statuaries to perpetuate the memory of great men, and to honour their gods with their representations as votives to the numerous temples, made liberal remuneration, and it is to be hoped equal to the merit of the work.

The Romans were fully sensible of the superior excellence of the Greeks in sculpture, and although we cannot approve of their motives in plundering them of their best works, yet we involuntarily feel satisfied that it is through their rapacity that we now possess those fascinating models for imitation, which has formed the taste of the Italian sculptors, and excited that emulation which enabled artists to rouze the public mind to a state of enthusiasm sufficiently powerful to crowd churches and palaces with mementos of the great and the good. Besides this superior branch of the art, we are not less indebted to the ancient Grecians for the invention and distribution of the most refined taste in the inferior parts of sculpture: under this head we need only remind the reader of the grand conceptions distributed from the base to the summit of Grecian buildings, in reliefs of various rich ornaments.

It appears almost superfluous to mention the Laocoon, the Venus di Medicis, the Apollo Belvidere, the Meleager, the Antinous, the Niobe, &c. &c. of the Grecian school, as efforts never to be exceeded, or perhaps equalled. How does this fact exalt the character of the people thus favoured, and how does it humble the pride of the moderns! And yet the knowledge of infinite superiority attached to them should not depress the efforts of the student, but rather rouze him to increased exertion; at all events recollecting, that Phidias, Praxitelles, Agesander, Polydore, and Athenodorus studied models far beyond the reach of perfect imitation, even the animated human form.

Our limits will not permit us to enlarge, or enter into an inquiry as to the comparative merits of the different modern schools of Europe, of which Italy bears away the unrivalled palm through several concurrent circumstances, and of those it is immediately obvious, that piety and superstition are the principal; the legends of their saints produce an incredible variety for illustrating the violent emotions of the soul in ardent devotion and the pangs of martyrdom, and it cannot be disputed, that they have in many instances very nearly approached the expression and excellence of their masters; of those Michael Angelo

Buonaroti has been honoured by his countrymen with the title of divine, nor was Bernini much less deserving of this honour.

The French, although favoured with a climate little inferior to that of Italy, and situated upon its borders, have less distinguished themselves in sculpture than might have been expected, but the national character is too volatile for the productions of tedious and incessant exertion, absolutely necessary in the sculptor; hence it is that very few French names are celebrated as statuaries. It would, however, be unjust not to mention Roubiliac, who honoured England with his works, which deserve every praise for just conception, and perhaps there is no modern instance of more beautiful contrast than in his monument to the memory of Lady Nightingale in Westminster Abbey, on which the lifeless figure of the dying lady, and the eager and terrified husband, have and ever will be greatly admired. The skeleton wrapped in sepulchral drapery, aiming a dart at the breast of the female, needs no other encomium than that of the celebrated anatomist John Hunter, who pronounced it a most perfect representation. François Girardon should also be mentioned as doing honour to the French nation by his numerous works, and by none more than his tomb of Cardinal Richlieu, originally placed in the college of the Sorbonne at Paris.

The Germans and Dutch have distinguished themselves greatly in painting, but taking the subject in an enlarged point of view, they have done next to nothing in sculpture; neither has the Spanish nation any very strong claim to distinction on this head. The sculpture of Great Britain is almost entirely confined to the interiors and exteriors of churches, and the statues which adorn them, are all, without exception, ancient; when the religion of our ancestors was the same as that of the greatest part of the continent of Europe, they gave large sums for the production of shrines and saints without number, but they seem to have had no idea of encouraging the noblest part of the art, by selecting men of superior genius, and employing them on groups or single figures in white marble, the only substance calculated to give due effect to the skill of the statuary; this parsimonious conduct, and probably very indifferent rewards, was the cause that all our old statues are made of coarse and perishable stone, and that they are in truth little better than copies of each other, which circumstance may be partly accounted for; besides, by the situations they occupied on the walls of sacred edifices, and their being invariably placed in niches, and those in the pointed style of artichecture, whence it became a matter of necessity to introduce but one figure, and that in an upright position; yet under all these disadvantages, a competent judge may discover in the majority of the works of our ancient sculptors a freedom and correctness that would, with due encouragement, have produced works little, if at all, inferior to those of the Italian school. If we examine the turns or lines of the faces of the kings and saints, scattered over the surfaces of our cathedrals and some parish churches, it will be found that the artists who made them were capable of expressing dignity and piety, and their drapery is generally correspondent to the position of the limbs, and in large graceful folds. The admirer of this art cannot fail of being highly gratified by tracing the progress of English sculpture in that vast field for observation, Westminster Abbey; where, in the cloisters, they will find the rude figures of abbots coeval with the time of William of Normandy, from which period down to the present moment there is almost an annual succession of figures ornamental and monumental.

The Abbey having been partly rebuilt by Henry III. the structure was continued as the abbots could obtain the means, consequently there is an actual gradation in the excellence of the sculpture down to the reign of Henry VII. The latter monarch determined to excel all his predecessors, and his chapel, or burial-place, is one blaze of rich decoration in every possible direction. Having thus directed the attention of the reader to the place where a perfect knowledge of this subject may be obtained, we shall proceed to notice another branch of the art, which has been continued in Great Britain from the time of the reformation, at which period sculpture received its fiat as far as relates to the use of it for pious purposes. We know but little of the statues which were placed about the altars and shrines of old times in this country, as they were destroyed without mercy, but vast numbers of tombs remain uninjured in every county; in speaking of those, we must premise that very little opportunity was given the artist to expand and improve his ideas, as a slavish custom prevailed of placing all the statues on them in a posture, of all others, the most rigid and ungraceful, which

was on their backs, and with the hands joined in prayer: under this obvious disadvantage our ancient sculptors contrived to make many excellent and interesting figures in beautiful transparent alabaster, although almost all the males are represented in armour. As the effigies of persons were frequently accompanied by that of their consort, more scope for genius and variety prevailed in the latter, and consequently we find females in the habits of their times, and represented in the rich ornaments of the sex, and making due allowance for the stiffness of their cumbent position, the drapery is frequently placed in true and well conceived folds; as to expression in the features beyond a mere state of quiet, as it would not have been proper, it is not to be discovered in any instance. Some of the tombs under consideration are divided into compartments, in each of which small bas reliefs are introduced of the children of the deceased, or monks or nuns telling their beads; these are frequently well executed, and so far so as to make us wish the artist had been indulged to the full extent of his abilities.

It appears, upon an attentive comparison, that the figures, executed between the reigns of Henry III. and Henry VII. are infinitely superior to those placed on tombs during and after the time of Henry VIII. as in his, and the two preceding reigns, the effigies were generally exhibited either kneeling at prayer, or cumbent, in a most miserable taste indeed, which was made still more disgusting by the custom of painting and gilding the drapery. In the period of the interregnum, nothing was done in the art of sculpture, as, unfortunately, the era alluded to completed the destruction begun at the reformation, by the application of a blind principle of dislike, which prevented the preservation of the statues of saints, not as objects to excite devotion, but as the only mementos that existed that the art had ever been encouraged in England.

As might have been anticipated, sculpture sunk into a state of total neglect, if not of contempt; but, after the restoration, the ancient habits of the people recurring, statues of the dethroned king, and of his son and successor, were erected in every direction, and in some instances they are tolerable figures; but the monumental of the same date are wretched indeed, as they are clad in Roman armour, and their heads and shoulders sustain enormous wigs. Encouragement increasing, the art began to rouze from its torpid state, and at length Cibber flourished, to whom we are indebted for many very excellent statues, and some rich embellishments at St. Paul's cathedral. Without invidiously mentioning names and making comparisons, it would be impossible to enter more fully into the progress of sculpture since the date just mentioned; we shall therefore merely say, that numerous proofs exist that the modern English possess a genius for sculpture equal to the inhabitants of any nation, but unfortunately it seems to be nearly confined to the execution of monuments, on which a routine of genii, ancient gods and goddesses, and virtues, are constantly introduced, to the total extinction of taste, as they must each possess their attributes to point out their names.

Little need be said of the mechanical part of this art, as various chissels, a mallet, compasses, and materials for polishing marble, are all that is required; the essential is seated in the mind, and as Roubiliac used to say, "the figure is in the substance of the marble, I only extricate it from the enclosure, or pick it out."

SCUTAGE, was anciently a tax imposed on such as held lands, &c. by knight's service, towards furnishing the King's army: hence scutagio habendo was a writ that lay for the king, or other lord, against tenants holding by knight's service, to serve in person, or send a sufficient man in their room, or pay a certain sum, &c.

SCUTELLARIA, in botany, *skull-cap*, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: calyx with an entire mouth, after flowering closed by a lid. There are sixteen species; these are all perennial plants, chiefly herbaceous, with square stalks, and opposite leaves; the flowers are either solitary, axillary, and naked, or else in terminating bracted spikes, with one bracte, or floral leaf to each flower; they are chiefly natives of the South of Europe.

SCUTTLES, in a ship, square holes cut in the deck, big enough to let in the body of a man, serving to let people down into any room below upon occasion, or from one deck to another. They are generally before the main-mast, before the knight in the forecastle; in the gun-room, to go down to the stern-sheets; in the round-house, to go down into the captain's cabin, when forced by the enemy in a fight aloft. There are also some smaller scuttles, which have gratings over them: and all of them have

covers, that people may not fall down through them in the night. Scuttle is also a name given to those little windows and long holes which are cut out in cabins, to let in light.

SCYLLÆA, in natural history, a genus of the Vermes Mollusca class and order. Body compressed, and grooved along the back; mouth consists of a terminal toothless aperture; tentacula, or arms, three on each side, and placed beneath. Two species are noticed, *viz.* the Pelagica and Gomphodensis.

SCYTHROPS, the *Channel-bill*, in natural history; a genus of birds of the order Picæ. Generic character: the bill large, convex, cultrated, furrowed at the sides, hooked at the tip; nostrils round, naked at the base of the bill; tongue cartilaginous, split at the point; toes two before, and two behind; tail of ten feathers. Of this genus only one species is known. This is an inhabitant of New South Wales, and is generally designated as the New South Wales Channel-bird. Its size is that of a crow; but its length is considerably greater, measuring two feet seven inches. It is seldom seen, excepting in the morning and evening, generally in pairs, sometimes in very small flocks; its noise resembles the screaming sound of alarm uttered by poultry in danger. It is migratory, and supposed to feed on the seeds of trees, on fruits, and the exuviæ of beetles. The tail is sometimes unfolded like a fan, both during the flight and sitting of the bird, and gives it an interesting and dignified appearance. It appears not to be easily tameable; but of the nature, manners, and habits of this bird, little is at present ascertained.

SEA, is frequently used for that vast tract of water encompassing the whole earth; but is more properly a part or division of these waters, and is better defined a lesser assemblage of water, which lies before, and washeth the coasts of, some particular countries, from whence it is generally denominated, as the Irish Sea, the Mediterranean Sea, the Arabian Sea, &c.

What proportion the superficies of the sea bears to that of the land, is not precisely known, though it is said to be somewhat more than two-thirds. As the waters of the earth must necessarily rise to the surface thereof, as being specifically lighter than the earth, it was necessary there should be large cavities therein, for receptacles to contain them, otherwise they would have overspread all the superficies of the earth, and so have rendered it utterly uninhabitable for terrestrial animals; for the centre of the earth being the common centre of gravity, and the nature of fluids being such, that they equally yield to equal powers; and the power of attraction being every where equal at equal distances from the centre, it follows, that the superficial parts of the water will every where conform themselves to an equidistant situation from the centre, and, consequently, will form the surface of a sphere, so far as they extend. Hence, that the sea seems higher than the earth or land, results from the fallacy of vision, whereby all objects, and the parts of land as well as sea, the further they are off from us, the higher they appear; the reason of all which is plain from optics; for it is well known, that the denser any medium is, through which we behold objects, the greater is the refraction; or the more their images appear above the horizontal level; also the greater quantity of the medium the rays pass through, the more will they be bent from their first direction; on both these accounts, the appearances of things remote, and on the sea, will be somewhat above the horizon, and the more so as they are the more remote.

With regard to the depth or profundity of the sea, Varenius affirms, that it is in some places unfathomable, and in other places very various, being in certain places $\frac{1}{20}$, $\frac{1}{5}$, $\frac{45}{100}$, $1\frac{1}{10}$, $2\frac{2}{10}$, $4\frac{1}{2}$ English miles, in other places deeper, and much less in bays than in oceans. In general, the depths of the sea bear a great analogy to the height of mountains on the land, so far as is hitherto discovered: and it is a general rule among sailors, and is found to hold true in many instances, that the more the shores of any place are steep and high, forming perpendicular cliffs, the deeper the sea is below; and that, on the contrary, level shores denote shallow seas. Thus the deepest part of the Mediterranean is generally allowed to be under the height of Malta. And the observation of the strata of earth and other fossils, on and near the shores, may serve to form a good judgment as to the materials to be found in its bottom. For the veins of salt and of bitumen doubtless run on the same, and in the same order, as we see them at land; and the strata of rocks that serve to support the earth of hills and elevated places on shore, serve also, in the same continued chain, to support the immense quantity of water in the bason of the sea.

The coral fisheries have given occasion

to observe that there are many, and those very large caverns or hollows in the bottom of the sea, especially where it is rocky; and that the like caverns are sometimes found in the perpendicular rocks which form the steep sides of those fisheries. These caverns are often of great depth, as well as extent, and have sometimes wide mouths, and sometimes only narrow entrances into large and spacious hollows.

The bottom of the sea is covered with a variety of matters, such as could not be imagined by any but those who have examined into it, especially in deep water, where the surface only is disturbed by tides and storms, the lower part, and consequently its bed at the bottom, remaining for ages, perhaps, undisturbed. The soundings, when the plummet first touches the ground, on approaching the shores, give some idea of this. The bottom of the plummet is hollowed, and in that hollow there is placed a lump of tallow; which, being the part that first touches the ground, the soft nature of the fat receives into it some part of those substances which it meets with at the bottom: this matter, thus brought up, is sometimes pure sand, sometimes a kind of sand made of the fragment of shells, beaten to a sort of powder, sometimes it is made of a like powder of the several sorts of corals, and sometimes it is composed of fragments of rocks; but beside these appearances, which are natural enough, and are what might well be expected, it brings up substances which are of the most beautiful colours.

Dr. Donati, in an Italian work, containing an essay towards a natural history of the Adriatic Sea, has related many curious observations on this subject; having carefully examined the soil and productions of the various countries that surround the Adriatic Sea, and compared them with those which he took up from the bottom of the sea, he found that there is very little difference between the former and the latter. At the bottom of the water there are mountains, plains, vallies and caverns, similar to those upon land. The soil consists of different strata, placed one upon another, and mostly parallel and correspondent to those of the rocks, islands, and neighbouring continents. They contain stones of different sorts, minerals, metals, various putrified bodies, pumice stones, and lavas formed by volcanos.

One of the objects which most excited his attention, was a crust, which he discovered under the water, composed of crustaceous and testaceous bodies, and beds of polypes of different kinds, confusedly blended with earth, sand, and gravel; the different marine bodies which form this crust, are found at the depth of a foot or more, entirely petrified and reduced into marble; these, he supposes, are naturally placed under the sea when it covers them, and not by means of volcanos and earthquakes, as some have conjectured. On this account he imagines, that the bottom of the sea is constantly rising higher and higher, with which other obvious causes of increase concur; and from this rising of the bottom of the sea, that of its level or surface naturally results; in proof of which, this writer recites a great number of facts.

M. Dassie has been at great pains to prove, that the sea has a general motion, independently of winds and tides, and of more consequence in navigation than is generally supposed. He affirms, that this motion is from east to west, inclining towards the north, when the sun has passed the equinoctial northward, and that during the time the sun is in the northern signs; but the contrary way after the sun has passed the said equinoctial southward: adding, that when this general motion is changed, the diurnal flux is changed also; whence it happens, that in several places the tides come in, during one part of the year, and go out during the other, as on the coasts of Norway, in the Indies at Goa, Cochinchina, &c, where, while the sun is in the summer signs, the sea runs to the shore; and when in the winter signs runs from it. On the most southern coasts of Tonquin and China, for the six summer months, the diurnal course runs from the north with the ocean; but the sun having re-passed the line toward the south, the course declines also southward.

There are two principal reasons why the sea does not increase by means of rivers, &c. falling every where into it. The first is, because waters return from the sea by subterranean cavities and aqueducts, through various parts of the earth. Secondly, because the quantity of vapours raised from the sea, and falling on the land, only cause a circulation, but no increase of water. It has been found, by calculation, that in a summer's day there may be raised in vapours, from the Mediterranean Sea, 5,280,000,000 tuns of water; and yet this sea receiveth not, from all its nine great rivers, above 1,827,000,000 tuns per day, which is but a third part of what is exhausted in vapours.

The ascent of the sea-water, for the formation of springs, by a subterranean circulation of its water to their sources, has been a great objection with many, against the system of their being formed of the sea; but Dr. Plot has observed, that there are many ways by which the water may ascend above its own level: 1. By the means of subterranean heats. 2. By filtration. 3. By the unequal height of several seas. 4. By the distance of the centre of magnitude from the centre of gravity, in the terraqueous globe; the superficies of the Pacific Sea is said to be further from the centre of gravity, than the top of the highest hill on the adverse part of the globe. And, 5. By the help of storms. The sea water actually ascends above its own level, coming into wells whose bottoms lie higher than the surface of the sea at high-water mark.

With regard to the saltness of the sea-water, it is very rationally judged to arise from great multitudes both of mines and mountains of salt, dispersed here and there in the depths of the sea. The salt being continually diluted and dissolved by the water, the sea becomes impregnated with its particles throughout, and for this reason the saltness of the sea can never be diminished. Dr. Halley supposes, that it is probable the greatest part of the sea-salt, and of all salt lakes, as the Caspian Sea, the Dead Sea, the Lake of Mexico, and the Titicaca, in Peru, is derived from the water of the rivers which they receive, and since this sort of lakes has no exit or discharge, but by the exhalation of vapours; and also since these vapours are entirely fresh, or devoid of such particles, it is certain, that the saltness of the sea and such lakes must, from time to time, increase, and therefore, the saltness at this time is greater than at any time heretofore. He further adds, that if, by experiments made in different ages, we could find the different quantity of salt, which the same quantity of water (taken up in the same place, and in all other the same circumstances) would afford, it would be easy from thence, by rules of proportion, to find the age of the world very nearly, or the time wherein it has been acquiring its present saltness.

The Bishop of Landaff has recommended a most simple and easy mode of ascertaining the saltness of the sea in any latitude; we insert it in his own words.

"As it is not every person who can make himself expert in the use of the common means of estimating the quantity of salt contained in sea-water, I will mention a method of doing it which is so easy and simple, that every common sailor may understand and practise it, and which, from the trials I have made of it, seems to be as exact a method as any that has yet been thought of. Take a clean towel, or any other piece of cloth, dry it well in the sun, or before the fire, then weigh it accurately, and note down its weight, dip it in the sea water, and when taken out, wring it a little till it will not drip, when hung up to dry, weigh it in this wet state, then dry it either in the sun, or at the fire, and, when it is perfectly dry, weigh it again. The excess of the weight of the wetted cloth above its original weight, is the weight of the sea-water imbibed by the cloth; and the excess of the weight of the cloth after being dried, above its original weight, is the weight of the salt retained by the cloth, and by comparing this weight with the weight of the sea-water imbibed by the cloth, we obtain the proportion of salt contained in that species of sea-water.

"Whoever undertakes to ascertain the quantity of salt contained in sea-water, either by this or any other method, would do well to observe the state of the weather preceding the time when the sea water is taken out of the sea, for the quantity of salt contained in the water near the surface may be influenced both by the antecedent moisture and the antecedent heat of the atmosphere."

Whether the sea is salter or not at different depths, has not yet been properly ascertained, but that its temperature varies considerably in proportion to the depth, we have decisive proof.

"With respect to the temperature," says Bishop Watson, "of the sea at different depths, it seems reasonable enough to suppose, that in summer time it will be hotter at the surface than at any considerable depth below it, and that in winter it will be colder.

"Mr. Wales describes the instrument he made use of for trying the temperature of the sea at different depths, in the following terms: 'The apparatus for trying the sea-water at different depths consisted of a square wooden tube of about eighteen inches long, and three inches square externally. It was fitted with a valve at the bottom, and another at the top, and had a contrivance for suspending the thermometer exactly in the middle of it. When it

was used it was fastened to the deep sea-line, just above the lead, so that all the way as it descended, the water had a free passage through it, by means of the valves which were then both open; but the instant it began to be drawn up, both the valves closed by the pressure of the water, and of course the thermometer was brought up in a body of water of the same temperature with that it was let down to.' With this instrument, which is much the same with one formerly described by Mr. Boyle, in his observations about the saltness of the sea, water was fetched up from different depths, and its temperature accurately noticed, in different seasons and latitudes.

"August 27, 1772, south latitude 24° 40'. The heat of the air was $72\frac{1}{2}$, of the water at the surface 70, of water from the depth of 80 fathoms 68.

"December 27, 1772, south latitude 58° 21'. The heat of the air was 31, of the water at the surface 32, of water from the depth of 160 fathoms $33\frac{1}{2}$.

"In the voyage to the high northern latitudes before mentioned, they made use of a bottle to bring up water from the bottom, which is thus described: 'The bottle had a coating of wool, three inches thick, which was wrapped up in an oiled skin, and let into a leather purse, and the whole inclosed in a well-pitched canvas bag, firmly tied to the mouth of the bottle, so that not a drop of water could penetrate to its surface. A bit of lead shaped like a cone, with its base downwards, and a cord fixed to its small end, was put into the bottle; and a piece of valve leather, with half a dozen slips of thin bladder, were strung on the cord, which, when pulled, effectually corked the bottle on the inside.' We have here put down two of the experiments which were made during that voyage.

"August 4, 1773, north latitude 80° 30'. The heat of the air was 32, of the water at the surface 36, of water fetched up from the depth of 60 fathoms under the ice, 39.

"September 4, 1773, north latitude 65°. The heat of the air was $66\frac{1}{2}$, of the water at the surface 55, of water from the depth of 683 fathoms, 40.

"It appears from all these experiments that, when the atmosphere was hotter than the surface of the sea, the superficial water was hotter than that at a great depth; and when the atmosphere was colder than the surface of the sea, it is evident that the superficial water was somewhat colder than at a considerable distance below it."

Sea-water may be rendered fresh by freezing, which excludes or precipitates the saline particles; or by distillation, which leaves the salt in a mass at the bottom of the vessel. Upon these principles, a mode of obtaining a supply of fresh water at sea was recommended some years ago to the Admiralty, by Dr. Irving. It consisted in only adapting a tin tube of suitable dimensions to the lid of the common ship's kettle, and condensing the steam in a hogshead which served as a receiver. By this mode a supply of twenty-five gallons of fresh water per hour might be obtained from the kettle of one of our ships of war.

The saline taste of sea-water, is chiefly derived from common salt which it holds in solution. Sea-water is also distinguished by a nauseous bitter taste, which is ascribed to the animal and vegetable matters which are floating in it. This taste has been considered as in some measure foreign to it, for it is only found in the water on the surface of the ocean, or near the shores. Sea-water, taken up at considerable depths, contains only saline matters. The specific gravity of sea-water varies from 1.027 to 1.028. Its greater density is owing to the salts which are dissolved in it; and to this impregnation also it is owing, that it is not frozen till the temperature is reduced nearly to 28°. The salts which are chiefly found in sea-water, are muriate of soda, or common salt, muriate of magnesia, sulphate of magnesia, sulphate of lime and soda. The quantity of saline ingredients in the waters of the ocean varies from $\frac{1}{24}$ to $\frac{1}{12}$ part. Mr. Kirwan makes the average quantity about $\frac{1}{28}$ of its whole weight. The quantity of saline contents of water, taken up by Lord Mulgrave at the back of Yarmouth Sands, in latitude 53°, amounted nearly to $\frac{1}{28}$; while Bergman found the water taken up in the latitude of the Canaries, to contain about $\frac{1}{12}$ of its weight of saline matter. These quantities, however, vary even in the same latitude, during rainy and dry seasons, near the land, or the mouths of great rivers. The difference of latitude does not seem to make any considerable difference in the proportion of saline matter. In latitude 80° north, sixty fathoms under ice, sea-water taken up by Lord Mulgrave, yielded about $\frac{1}{28}$; in latitude 74°, nearly the same; and in latitude 60°, $\frac{1}{29}$. Pages obtained four per cent. from water taken up in latitude 81°, and the same quantity of saline matter from water taken up in latitudes 45° and 39° north. In southern lati-

tudes the proportion was still greater; he found it to contain the following proportions: In the Mediterranean the proportion is said to be still greater; but the Euxine and Caspian seas are found to be less salt than the ocean. This is also the case with the Baltic. If the saline matters of the waters of the ocean did not consist of different kinds, the proportion of salts which it contains might be ascertained by the specific gravity. The experiments of Mr. Wilcke show that the proportion of saline matter in the Baltic is less than that of the ocean: and that it is salter during the prevalence of a westerly wind, by which the water is driven from the ocean, than during an easterly wind. The proportions of the different salts in an analysis, by Bergman, are the following:

Muriate of soda	30.911
Muriate of magnesia	6.222
Sulphate of lime	1.000
	38.133

In 1,000 parts of water taken up near Dieppe, Lavoisier found the following salts:

Muriate of soda	1375
Muriate of lime and magnesia	256
Muriate of magnesia	156
Lime	87
Sulphate of soda and magnesia	84
	1958

The luminousness of the sea is a phenomenon that has been noticed by many nautical and philosophical writers. Mr. Boyle ascribes it to some cosmical law or custom of the terrestrial globe, or at least of the planetary vortex.

The Abbé Nollet was long of opinion, that the light of the sea proceeded from electricity; and others have had recourse to the same principle, and shown that the luminous points in the surface of the sea are produced merely by friction.

There are, however, two other hypotheses, which have more generally divided between them the solution of this phenomenon; the one of these ascribes it to the shining of luminous insects or animalcules, and the other to the light proceeding from the putrefaction of animal substances. The Abbé Nollet, who at first considered this luminousness as an electrical phenomenon, having had an opportunity of observing the circumstances of it, when he was at Venice in 1749, relinquished his former opinion, and concluded that it was occasioned either by the luminous aspect, or by some liquor or effluvia of an insect which he particularly describes, though he does not altogether exclude other causes, and especially the spawn or fry of fish. A similar conjecture is proposed by a correspondent of Dr. Franklin, in a letter read at the Royal Society in 1756; the writer of which apprehends, that this appearance may be caused by a great number of little animals, floating on the surface of the sea. And Mr. Forster, in his account of a voyage round the world with Captain Cook, describes this phenomenon as a kind of blaze of the sea; and having attentively examined some of the shining water, expresses his conviction that the appearance was occasioned by innumerable minute animals of a round shape, moving through the water in all directions, which show separately as so many luminous sparks when taken up on the hand: he imagines that these small gelatinous luminous specks may be the young fry of certain species of some medusæ or blubber. And M. Dagelat and M. Rigaud observed several times, and in different parts of the ocean, such luminous appearances by vast masses of different animalcules; and a few days after, the sea was covered, near the coasts, with whole banks of small fish in innumerable multitudes, which they supposed had proceeded from the shining animalcules.

But M. le Roi, after giving much attention to this phenomenon, concludes, that it is not occasioned by any shining insects, especially as, after carefully examining with a microscope some of the luminous points, he found them to have no appearance of an animal; and he also found that the mixture of a little spirits of wine with water just drawn from the sea, would give the appearance of a great number of little sparks, which would continue visible longer than those in the ocean: the same effect was produced by all the acids, and various other liqours. M. le Roi is far from asserting that there are no luminous insects in the sea; for he allows that several gentlemen have found them; but he is satisfied that the sea is luminous chiefly on some other account, though he does not so much as offer a conjecture with respect to the true cause.

Other authors, equally dissatisfied with the hypothesis of luminous insects, for explaining the phenomenon which is the sub-

ject of this article, have ascribed it to some substance of the phosphoric kind, arising from putrefaction.

Sea, in law: The sea shall be open to all merchants. The main sea beneath the low water mark, and round England, is part of England; and the admiralty has jurisdiction there.

SEAMEN, such as are reserved to serve the King, or other persons, at sea, who may not depart without license, &c. Seamen fighting, quarreling, or making any disturbance, may be punished by the commissioners of the navy, with fine and imprisonment. Registered seamen are exempted from serving in any parish office, &c. and are allowed bounty money besides their pay. By the law of merchants, the seamen of a vessel are accountable to the master or commander, and the master to the owners, and the owners to the merchants, for damage sustained either by negligence or otherwise. Where a seaman is hired for a voyage, and he deserts it before it is ended, he shall lose his wages; and in case a ship be lost by a tempest, or in a storm, the seamen lose their wages, as well as the owners their freight.

Seamen, in law: by various statutes, sailors having served the King for a limited time, are free to use any trade or profession, in any town of the kingdom. By 2 George II. c. 36, made perpetually by 2 George III. c. 31, no master of any vessel shall carry to sea any seaman, his own apprentice excepted, without first entering into an agreement with such seaman for his wages; such agreement to be made in writing, and to declare what wages such seaman is to receive during the whole of the voyage, or for such time as shall be therein agreed upon; and such agreement shall also express the voyage for which such seaman was shipped to perform the same, under a penalty of 10*l.* for each mariner carried to sea without such agreement, to be forfeited by the master to the use of Greenwich Hospital. This agreement is to be signed by each mariner within three days after entering on board such ship, and is; when executed, binding on all parties.

SEAL, a puncheon, or piece of metal, or other matter, usually either round or oval, whereon are engraven the arms, device, &c. of some prince, state, community, magistrate, or private person, often with a legend or suscription, the impression of whereof in wax, serves to make acts, instruments, &c. authentic.

Before the time of William the Conqueror, the makers of all deeds only subscribed their names, adding the sign of the cross, and a great number of witnesses; but that monarch and the nobility used seals with their arms on them, which example was afterwards followed by others. The colour of the wax wherewith this King's grants were sealed was usually green, to signify that the act continued fresh for ever, and of force. A seal is absolutely necessary in respect of deeds, because the sealing of them makes persons parties thereto, and without being sealed, they are void in law.

SEALER, an officer in chancery appointed by the Lord Chancellor, or Keeper of the great seal, to seal the writs and instruments there made in his presence.

SEAMS *of a ship*, are places where her planks meet and join together. There is also a kind of peculiar seam in the sowing of sails, which they call monk-seam; the other seam of a sail is the round-seam, so called from its being round like the common seams.

SEARCHER. See Alnager. Searcher is also an officer of the customs, whose business is to search and examine all ships outward bound, to see whether they have any prohibited or unaccustomed goods on board.

SEAR *cloth*, or Cere *cloth*, in surgery, a form of external remedy somewhat harder than an unguent, yet softer than an emplaster, though it is frequently used both for the one and the other. The sear-cloth is always supposed to have wax in its composition, which distinguishes and even denominates it. In effect, when a liniment or unguent has wax enough in it, it does not differ from a sear-cloth.

SEBACIC *acid*, the acid of fat. The penetrating fumes which are exhaled from melted tallow, and which affect the eyes, the nostrils, and even the lungs, had been long ago observed. Little attention, however, was paid to their nature and properties. In 1754 appeared a dissertation by M. Seguer, on the acid of animal fat, which contained a number of well-conducted experiments. Crell endeavoured to improve the process for the separation and purification of this acid, and to ascertain the properties of its combinations. These were published in the Philosophical Transactions for the years 1780 and 1782. But it appears, that the acid obtained by those who first treated of the subject, was either the acetic acid, or some acid different from the

sebacic, the properties of which are quite distinct from those which had been formerly described. The process by which Thenard obtained the sebacic acid is the following. He distilled a quantity of hogs-lard, and washed the product several times with hot water. He then dropped into it acetate of lead; there was formed a flakey precipitate, which was collected and dried, put into a retort with sulphuric acid, and heated. The liquor in the receiver had no acid character; but there appeared in the retort a melted matter analogous to fat. This is carefully separated, and after being washed, is boiled with water. By the action of heat the whole is dissolved by the water, and when it cools, crystals in the shape of needles are deposited. These are the sebacic acid which has the following properties. It has no smell, a slight acid taste, and reddens strongly the tincture of turnsole. When heated it melts like tallow. It is much more soluble in warm than in cold water. Alcohol dissolves it in large quantities. Boiling water saturated with this acid forms a solid mass on cooling. It crystallizes in small needles, but with certain precautions may be obtained in the form of long, large, and very brilliant plates. It precipitates the acetate and nitrate of mercury and lead, and nitrate of silver; it neutralizes the alkalies, and forms with them soluble salts.

SEBATES, in chemistry, salts formed of the sebacic acids, and alkalies, earths, &c.; they are soluble in water.

SECALE, in botany, *rye*, a genus of the Triandria Digynia class and order. Natural order of Gramina or Grasses. Essential character: calyx opposite, two-valved, two-flowered, solitary. There are four species, *viz.* the villosum, orientale, creticum, and cereale. S. villosum, or wood rye-grass, is distinguished by a calyx with wedge-shaped scales, and by the fringe of the glume being woolly. The glumes of the S. orientale are shaggy, and the scales of the calyx are shaped like an awl. The glumes of the S. creticum are fringed on the outside. The S. cereale, or common rye, has glumes with rough fringes. It is a native of the island of Candia, was introduced into England many ages ago, and is the only species of rye cultivated in this kingdom. There are, however, two varieties, the winter and spring rye. The winter rye, which is larger in the grain than the spring rye, is sown in autumn at the same time with wheat, and sometimes mixed with it; b as the rye ripens sooner than the wheat, this method must be very exceptionable. The spring rye is sown along with oats, and usually ripens as soon as the winter rye; but the grain produced is lighter, and it is therefore seldom sown except where the autumnal crop has failed. Rye is commonly sown on poor, dry, limestone, or sandy soils, where wheat will not thrive. By continuing to sow it on such a soil for two or three years, it will at length ripen a month earlier than that which has been raised for years on strong cold ground.

SECANT, in geometry, is a line that cuts another, or divides it into two parts.

In trigonometry, the secant denotes a right line drawn from the centre of a circle, which cutting the circumference, proceeds till it meets with a tangent to the same circle.

SECHIUM, in botany, a genus of the Monoecia Syngenesia class and order. Natural order of Euphorbiæ, Jussieu. Essential character: calyx half, five-cleft; corolla five-cleft, with ten hollows in the upper part of the tube; nectary: male, filaments five, connected: female, stigma very large, peltate reflexed, five cleft; pericarpium large, ovate, turbinate, one-seeded. There is only one species, *viz.* S. edule, the chocho vine. It is a native of the West Indies; flowering and fruiting in December.

SECOND, in geometry, chronology, &c. the sixtieth part of a prime or minute; whether of a degree, or of an hour; it is denoted by two small accents, thus (″).

SECRETARY, an officer who by his master's orders writes letters, dispatches, and other instruments, which he renders authentic by his signet. Of these there are several kinds; as, 1. Secretaries of State, who are officers that have under their management and direction the most important affairs of the kingdom, and are obliged constantly to attend on the King: they receive and dispatch whatever comes to their hands, either from the crown, the church, the army, private grants, pardons, dispensations, &c. as likewise petitions to the sovereign, which, when read, are returned to them; all which they dispatch according to the King's direction. They have authority to commit persons for treason and other offences against the state, as conservators of the peace, at common law, or as justices of the peace throughout the kingdom. They are members of the Privy Council, which is seldom or never held without one of them being present; and as to the business and correspondence in all parts of this kingdom,

it is managed by either of the secretaries, without any distinction; but with respect to foreign affairs the business is divided into two provinces or departments, the southern and the northern, comprehending all the kingdoms and states that have any intercourse with Great Britain; each secretary receiving all letters and addresses from, and making all dispatches to, the several princes and states comprehended in his province. 2. Secretary of an Embassy, a person attending an embassador for writing dispatches relating to the negociation. There is a great difference between the secretary of an embassy, and the embassador's secretary; the last being a domestic or menial of the embassador, and the first a servant or minister of the prince. 3. The Secretary of War, an officer of the War Office, who has two chief clerks under him, the last of which is the secretary's messenger. There are also secretaries in most of the other offices.

SECRETION. In the course of the circulation the blood is conveyed to certain organs named glands, and is there entirely changed in its chemical composition, so as to form various products not pre-existing in the mass of blood, and which form some of the most important varieties of animal matter. See PHYSIOLOGY.

SECTION, in geometry, denotes a side or surface appearing of a body or figure cut by another; or the place where lines, planes, &c. cut each other. The common section of two planes is always a right line; being the line supposed to be drawn on one plane by the section of the other, or by its entrance into it.

SECTION *of a building*, in architecture, is the same with its profile; or a delineation of its heights and depths raised on a plane, as if the fabric was cut asunder to discover its inside.

SECTOR, in geometry, is a part of a circle, comprehended between two radii and the arch; or it is a mixed triangle, formed by two radii and the arch of a circle.

SECTOR is also a mathematical instrument, of great use in finding the proportion between quantities of the same kind, as between lines and lines, surfaces and surfaces, &c. for which reason the French call it the compass of proportion.

The great advantage of the sector above common scales, &c. is, that it is adapted to all radii, and all scales. For, by the line of chords, sines, tangents, &c. on the sector, we have lines of chords, sines, tangents, &c. adapted to any radius between the length and breadth of the sector, when opened. The sector is founded on the fourth proposition of the sixth book of Euclid, where it is demonstrated, that similar triangles have their homologous sides proportional. See MATHEMATICAL INSTRUMENTS.

SECUNDINES, *after birth*, in anatomy, the several coats or membranes wherein the fœtus is wrapped up in the mother's womb, as the chorion and amnios, with the placenta, &c. See MIDWIFERY.

SECURIDACA, in botany, a genus of the Diadelphia Octandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: calyx three-leaved; corolla papilionaceous, with the standard two-leaved within the wings; legume ovate, one-celled, one-seeded, ending in a ligulate wing. There are three species.

SEDUM, in botany, *stonecrop*, a genus of the Decandria Pentagynia class and order. Natural order of Succulentæ. Sempervivæ, Jussieu. Essential character:-calyx five-cleft; corolla five-petalled; scales nectariferous, five, at the base of the germ; capsules five. There are thirty species, all of which are hardy, herbaceous, succulent perennials, durable in root, but mostly annual in stalk, &c. which, rising in spring, flower in June, July, and August, in different sorts; the flowers consisting universally of five spreading petals, generally crowning the stalks numerously in corymbose and cymose bunches and spikes, appearing tolerably conspicuous, and are succeeded by plenty of seeds in autumn, by which they may be propagated, also abundantly by parting the roots, and by slips or cuttings of the stalks in summer; in all of which methods they readily grow, and spread very fast into tufted bunches; being all of succulent growth, they consequently delight most in dry soils, or in any dry rubbishy earth. As flowering plants, they are mostly employed to embellish rock-work, ruins, and the like places; planting either the roots or cuttings of the shoots in a little mud or any moist soil at first, placing it in the crevices, where they will soon root and fix themselves, and spread about very agreeably.

SEED, in botany, the essence of the fruit of every vegetable. Linnæus denominates it to be a deciduous part of the plant, containing the rudiments of the new vegetable, and fertilized by the sprinkling of the male dust. Plants are furnished with

one seed as the sea-pink; or two as in umbelleferous plants; or three as in the spurge: or many as in the ranunculus, &c. The shape, structure, and sides of seeds are various. Linnæus denominates seeds the eggs of plants; and the fecundity of plants is often astonishing: there are 4,000 seeds in a single sun-flower; more than 30,000 in a poppy; and in a single tobacco plant 360,000 have been enumerated. The annual produce of a single stalk of spleenworth has been estimated to be a million of seeds. Plants are disseminated in various methods: some are carried along by rivers and torrents many hundred miles from their native soil, and cast upon a very different climate, to which, however, by degrees they render themselves familar. Some are formed by wings to be borne before the wind to distant places. Birds, squirrels, &c. swallow seeds, and void them whole and fit for vegetation, and thus disseminate them. There are others that disperse themselves by an elastic force, that resides either in the "calyx", as in oats and the ferns: in their "pappus", as in the "centaurea crupina", or in their capsule, as in the geranium.

SEED. See SEMEN.

SEGMENT *of a circle*, in geometry, that part of the circle contained between a chord and an arch of the same circle.

SEGMENT *of a sphere*, is a part of a sphere terminated by a portion of its surface, and a plane which cuts it off, passing somewhere out of the centre; being more properly called the section of a sphere. The base of such a segment, it is evident, is always a circle. And the convex surfaces of different segments, are to each other as their altitudes, or versed sines. And as the whole convex surface of the sphere is equal to four of its great circles, or four circles of the same diameter; so the surface of any segment is equal to four circles on a diameter equal to the chord of half the arc of the segment. So that if d denotes the diameter of the sphere, or the chord of half the circumference, and c the chord of half the arc of any other segment, also a the altitude or versed sine of the same; then,

$3.1416d^2$ is the surface of the whole sphere, and

$3.1416c^2$, or $3.1416d$, the surface of the segment.

For the solid content of a segment, there are two rules usually given; *viz.* 1. To three times the square of the radius of its base, add the square of its height; multiply the sum by the height, and the product by .5236. Or, 2dly, From three times the diameter of the sphere, subtract twice the height of the frustrum; multiply the remainder by the square of the height, and the product by .5236.

SEGUIERIA, in botany, so named in honour of Jean François Seguier, a genus of the Polyandria Monogynia class and order. Essential character: calyx, five-leaved; corolla none; capsule, one-seeded, terminated by a large wing, having small lateral ones. There are two species, *viz.* S. Americana and S. Asiatica.

SEISIN, is two-fold, seisin in law, and seisin in fact. Seisin in fact, is when an actual possession is taken; seisin in law, when something is done, which the law accounts a seisin. See ESTATE, FEE, &c.

SELAGO, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of Aggregatæ. Vitices, Jussieu. Essential character: calyx, five-cleft; corolla, tube capillary, border almost equal; seed one or two. There are twenty species. These plants are herbaceous or shrubby; all natives of the Cape of Good Hope. Leaves alternate; flowers in most of the species, allied to those of eranthemum and verbena, irregular, tubular, in alternate terminating spikes, which are simple or manifold; in a few, the flowers are regular, with a short two seeded tube, in a sort of terminating corymb.

SELENITE, in mineralogy, a species of the Calc genus, is of a snow white colour, passing into different shades of grey. It is most generally massive, and not unfrequently crystallized; the crystals are seldom large; internally, its lustre shining and splendent. The fracture is perfectly foliated. It is transparent, soft, and not particularly frangible; specific gravity 2.3; it is composed of lime, sulphuric acid, and water, and is found in Germany, France, and England. On account of its great purity it is employed in taking the most delicate impressions: it is also used for crayons, and when burnt and powdered, it is used for cleansing silver. It is the same with GYPSUM, under which word will be found some other particulars relating to it.

SELEUCIDÆ, in chronology. Æra of the Seleucidæ, or the Syro-Macedonian æra, is a computation of time, commencing from the establishment of the Seleucidæ, a race of Greek kings, who reigned as successors of Alexander the Great, in Syria, as the

Ptolemies did in Egypt. This æra we find expressed in the book of the Maccabees, and on a great number of Greek medals, struck by the cities of Syria, &c. The rabbins call it the æra of contracts; and the Arabs *therik dilkarnain*, that is, the æra of the two horns. According to the best accounts, the first year of this æra falls in the year 311 before Christ, being twelve years after Alexander's death.

SELINUM, in botany, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ or Umbelliferæ. Essential character: petals, cordate, equal; involucre, reflex; fruit oval, oblong, compressed, flat, striated in the middle. There are nine species.

SELL, in building, is of two kinds, *viz.* ground-sell, which denotes the lowest piece of timber in a timber building, and that on which the whole superstructure is raised; and the window-sell, is the bottom piece in a window-frame.

SEMECARPUS, in botany, a genus of the Pentandria Trigynia class and order. Essential character: calyx inferior, five-cleft; corolla, five petalled; nut, kidney-form, inserted into a large fleshy, flattened receptacle. There is but one species, *viz.* S. anacardium, marking nut tree. It is a native of all the mountainous parts of India, flowering in July and August.

SEMEN. See PHYSIOLOGY. Semen is secreted in the testes of male animals; but when it is ejected it is composed of two substances; the one is fluid and milky, and the other of a thick mucilaginous consistence, in which appear a great number of white silky filaments, especially if it be agitated in cold water. It has a disagreeable odour, and an acrid irritating taste. The specific gravity varies considerably, but is always greater than that of water. When it is rubbed in a mortar, it froths up, and acquires the consistence of pomatum from the air with which it mixes. It converts the flowers of violets, to a green colour, and it precipitates the calcareous and metallic salts, which shows, that it contains an uncombined alkali. The thick part of the semen as it cools, becomes transparent, and assumes a greater degree of consistence; but it afterwards becomes entirely liquid, even without absorbing moisture from air. If semen be exposed to the air after it has become liquid at the temperature of sixty degrees, it becomes covered with a transparent pellicle, and at the end of three or four days deposits fine transparent crystals of a line in length, crossing each other like radii from a centre. When they are magnified, they appear to be four-sided prisms terminated by long four-sided pyramids. When semen is exposed to a warm air, in considerable quantity, it is decomposed; it assumes the colour of the yolk of egg, and becomes acid, either by absorbing the oxygen from the atmosphere, or by a different combination and arrangement of its own constituent principles. Heat accelerates the liquefaction of semen; and when it has undergone this change it is no longer susceptible of coagulation. It is decomposed by the application of strong heat. Water is first separated; it then blackens, swells up, and emits yellow fumes, having an empyreumatic, ammoniacal odour. A light coal remains behind, which burns readily to white ashes.

The acids readily dissolve semen, and this solution is not decomposed by the alkalies; nor indeed is the alkaline solution of semen decomposed by the acids. Wine, cider, and urine, also dissolve semen, but it is in consequence of the acid which is combined with these liquids. The crystals which form in semen by spontaneous evaporation in the open air, and which are entangled in the viscid matter, may be separated by adding water.

These crystals have neither smell nor taste. They melt under the blow-pipe into a white opaque globule, which is surrounded with a yellowish flame. This salt is insoluble in water, and is not acted on by the alkalies; but is soluble in the mineral acids without effervescence, from which solutions, lime-water, the alkalies, and oxalic acid throw down a precipitate. The component parts of semen are found to be

Water	90
Mucilage	6
Soda	1
Phosphate of lime	3
	100

SEMICIRCLE, in geometry, half a circle, or that figure comprehended between the diameter of a circle and half the circumference.

SEMICOLON, in grammar, one of the points or stops used to distinguish the several members of sentences from each other. See PUNCTUATION.

SEMICUBICAL *parabola*, in the higher geometry, a curve of the second order,

wherein the cubes of the ordinates are as the squares of the abscisses. Its equation is $axx = y^3$.

The area of the space A P M (Plate XIV. Miscel. fig. 1), is $= \frac{3}{5}\, xy = \frac{3}{5}$ A P $\times$ P M, or $\frac{3}{5}$ of the circumscribing rectangle. The content of the solid generated by the revolution of the space A P M about the axis A P, is $\frac{1}{4}\, p x y^2 = .7854$ A P $\times$ P M^2, or $\frac{1}{4}$ of the circumscribing cylinder. And a circle equal to the surface of that solid may be found from the quadrature of an hyperbolic space. Also the length of any arc, A M, of the curve may be easily obtained from the quadrature of a space contained under part of the curve of the common parabola, two semi-ordinates to the axis, and the part of the axis contained between them. This curve may be described by a continued motion, viz. by fastening the angle of a square in the vertex of a common parabola, and then carrying the intersection of one side of this square and a long ruler (which ruler always moves perpendicular to the axis of the parabola) along the curve of that parabola. For the intersection of the ruler, and the other side of the square will describe a semicubical parabola. Maclaurin performs this without a common parabola, in his Geometria Organica.

SEMIDIAMETER, half the diameter, or a right line drawn from the centre of a circle, or sphere, to its circumference; being the same with what is otherwise called the radius. The distances, diameters, &c. of the heavenly bodies, are usually estimated, by astronomers, in semidiameters of the earth, and the distances of the secondary planets from their respective primary ones, by semidiameters of the body of the primary planet.

Suppose the semidiameter of the Earth to be unity, then the measures of the Sun and planets will be as follow: The semidiameter of

The Earth	1
The Sun	111.25
The Moon	0.27
Mercury	0.38
Venus	1.15
Mars	0.65
Jupiter	11.81
Saturn	9.77
Herschel	4.32

SEMIPARABOLA, in geometry, a curve defined by the equation $ax^{m-1} = y^m$; as $ax^2 = y^3$, and $ax^3 = y^4$. In semiparabolas, $y^m : v^m :: ax^{m-1} : az^{m-1} = x^{m-1} : z^{m-1}$; or the powers of the semiordinates are, as the powers of the semiabscisses one degree lower, for instance, in cubical semiparabolas the cubes of the ordinates are as the squares of the abscisses; that is, $y^3 : v^3 :: x^2 : z^2$.

SEMPERVIVUM, in botany, *houseleek*, a genus of the Dodecandria Polygynia class and order. Natural order of Succulentæ. Sempervivæ, Jussieu. Essential character: calyx twelve parted, petals twelve, capsule twelve, many-seeded. There are fourteen species.

SENECIO, in botany, *groundsel*, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx cylindrical, calycled, with the scales mortified at the tip; down simple, receptacle naked. There are seventy five species.

SENSATION. The brain is a soft pulpy mass, of a whitish colour on the inside, occupying all the cavity of the skull. Minute differences are observable in the substance of the brain in different parts of it, but it is unnecessary to enter upon a statement of them here. (See ANATOMY.) The spinal marrow is the continuation of the lowest part of the brain, which passes through the great opening of the skull down the hollow of the back bone. The substance contained in the hollow of the back bone is the same with that in the cavities of the skull, and it is sometimes convenient to comprehend both the portions under the same general name of brain. From the brain proceeds the nerves, which at first are fine fibres of the same substance with the brain: these fibres meet and form soft white pulpy cords, which afterwards spread themselves over various parts of the body, by splitting into innumerable and exceedingly minute branches. Anatomists count forty pairs of nerves, (for they come off in pairs, though they afterwards separate), and of those nine or ten only come from the brain at the bottom of the skull, and the rest from the spinal marrow. Those from the brain are distributed to various parts of the head; those from the spinal marrow are distributed over the trunk and extremities. The external organs of sense, the nerves, and the brain, are the organs of sensation. All, as we are at present constituted, are necessary to sensation. If the external organ is destroyed no sensation can be produced: where there are no nerves

there is no sensation: where the nervous branches are most numerous, there is most sensation: if the nerve be destroyed, sensation cannot be produced from those parts to which the nerve belongs which are further from the brain than the injured parts. The brain is the ultimate organ of sensation of which we have any knowledge. All the nerves terminate in the brain. If the brain is compressed, sensation is suspended. If the brain is considerably injured, sensation ceases.—So also, there is considerable reason to believe that the brain is the immediate organ of ideas. If the brain is diseased, many of the phenomena of thought are altogether changed; if the brain is compressed, thought is suspended; if the brain is injured, ideas cease.—So also, the brain appears to be the ultimate organ of all motions which are not produced by the immediate action of external objects upon the muscles. The muscles are the immediate organs of motion. The muscles consist of fleshy substances, and sometimes of tendon. The tendons fasten the muscles to the bones; and the fleshy part by its contractions produces the motions of the bones. Into the fleshy parts of the muscles numerous nerves enter; they are diffused over its surface and within its substance. These nerves, as before mentioned, terminate in the brain either of the head or back. They are the intermediate organs of voluntary motion between the brain and the muscles. If a nerve be compressed or punctured, motion is produced in the muscle over which that nerve is distributed. If a portion of a nerve be cut or otherwise destroyed, voluntary motion can no longer be produced in that muscle over which it was distributed. If the brain be touched with any instrument, or caustic applied to it, the muscular system undergoes the most violent contortions. If the spinal marrow be pierced with a probe, all the muscles of the trunk and limbs undergo violent contortions, particularly those of the back. If the brain be compressed, the whole body becomes paralysed, and the power of voluntary motion is suspended. If the spinal marrow be compressed, the power of voluntary motion is suspended in those muscles which receive their nerves from the back. If the brain is considerably injured, all power of voluntary motion ceases.

The external organs of sense are usually classed under five heads, those of sight, of hearing, of feeling, of smell, and of taste. The sense of feeling might probably be divided with convenience into two or three, because the classes of sensations, which are referred to this sense, differ considerably in themselves, and in the external causes producing them. But the common arrangement is sufficient for our purpose.

By the law of association many ideas received directly from sensible objects, through the medium of different senses, become connected, and at last blended together, so as to form one very complex, though apparently uncompounded, idea; and this complex idea is often recalled to the mind by a corresponding sensation, and, by association, becomes so connected with that sensation, that the complex idea itself is often mistaken for a part of the sensation. For instance, the sensation produced by the impression made by a globe, on the sense of sight, is, as can be proved, nothing more than that produced by a circle, with certain variations of light and shade; yet, immediately on the sensation being perceived, the ideas of its solidity, of its hardness, its magnitude, and of its being something external to one's self, (all of which have been derived from the sense of touch, in connection with this object or others in some respect similar), immediately rise up in the mind in one blended form; by their complete coalescence they appear to be one, and by their immediate and constant connection with the sensation, they appear to the mind as a part of the sensation. Indeed, there are comparatively few people who ever think that the sensation derived from the sight is nothing more than that derived from a minute picture delineated on the back part of the eye called the retina. Things appear to us, at one glance of the sight, to be solid or flat, to be near or distant, to be large or small, to be conjoined with other things, or separate from them, to be parts of our own frame, or external to it, &c. and all this we appear to learn by the sight alone: but the fact is, that all these ideas are derived from another sense at various times, and altogether blending together, and arising the moment the visible impression is communicated, they appear part of the visible impression "The visible appearance of objects," as Berkeley observes, "is a kind of language serving to inform us of their distance, magnitude, and figure:" no sooner are these signs presented to the mind, than with the rapidity of lightning the ideas associated with them succeed, and appear to have been communicated by the sight, and to be in reality a part of the sensation.

The sensation thus connected with the complex idea is a perception. The accuracy and vividness of the sensation depends entirely upon the sensitive power and its organs: the accuracy and vividness of the perception depends partly upon the accuracy and vividness of the component sensations, and partly upon the activity and energy of the retentive and associative powers.

For a somewhat particular account of each sense, with statements respecting the share each has in forming our ideas, i. e. our notions and our feelings, we beg our readers to refer in this place to the following articles, in the order in which we here detail them; SIGHT, TOUCH, TASTE, SMELL, and SOUND: and presuming upon the perusal of those articles, we shall here make a few general observations respecting sensations.

1. Sensations are the rudiments and elements of all our ideas; that is, of all our thoughts and feelings.—This is a position which perhaps few of those who are unacquainted with the speculations of metaphysical writers would suppose to have been ever doubted. When an infant enters into the world, there is no appearance of any ideas being in its mind; and no one can doubt, that if any human being could be deprived of all his organs and sensations, before any sensations had been received, that he would never have ideas. Yet it was once generally believed, that there are in every human being ideas born with him, which were called innate. What they were, or in what respects they differed from those which are indisputably received by means of the organs of sensation, was never, we apprehend, pointed out. Indeed the doctrine of innate ideas rests merely on an appeal to ignorance; and as soon as any probable account of their origin is given, all support of it falls at once. Before the grand law of association was tolerably understood, the mode of the formation of many complex ideas could not be satisfactorily ascertained; and it must still be admitted, that we cannot in all cases fully trace the formation of our complex ideas; but we can in a sufficient number to decide the point. Between those whose formation we can explain, and those whose we cannot, there is no further difference than our greater or less acquaintance with the individual steps of the process.

2. In the earliest exercise of the sensitive power, sensations are simple, uncompounded with the relicts of former corresponding sensations; but the sensations very soon become perceptions, that is, they instantaneously recal the relicts of other corresponding sensations. This implies the exercise of the retentive and associative power; but as perceptions are almost uniformly produced by every exercise of the sensitive power, it may be proper to speak of them here in connection with sensations. That sensations in a somewhat advanced state of mental culture are usually perceptions, any person may satisfy himself, by considering, that sensations are usually accompanied either with an idea of an external object causing them, or (if they are thereby the effect of the state of the bodily system) with an idea of the sensation being in the part of the body in which the cause of the sensation exists; both of which are complex ideas, formed from a great number of impressions, and which could in no instance be produced by any exertion of the sensitive power.—We, therefore, in many cases, without any impropriety, speak of perceptions and sensations indiscriminately; since a perception always implies a sensation, and sensations most frequently are perceptions; and accordingly we shall find in some writers that they are confounded, sometimes where they ought to be kept distinct.

3. Considering man as an intellectual being, the accuracy and extent of his perceptions are of the first moment. They are, in fact, the materials of all knowledge respecting external objects, and in the early stages of mental culture are the only objects of the understanding. Now the accuracy and extent of the perception depends upon the vividness and efficaciousness of the component sensations, and the number of them received from the same or similar objects in different situations, and through the medium of different senses.—The object therefore of the early education of the human being, should be to invigorate the organs of sense. Independently of the effects of the general healthiness of the system, it appears decidedly probable that the organs of sense are capable of being improved by exercise. It is the grand law of our frame, that moderate exertion increases the power of exertion; and assuredly there are facts which lead to the same conclusion in this particular case. But this may be safely left to the natural effect of exertion. All that is to be done is to afford children the opportunity of exercising their senses on a variety of objects, and as much as possible

in a variety of situations.—Some have supposed that the senses are not capable of improvement. We readily grant, that the superiority possessed by some over others in the use of their senses, principally consists in the extent and accuracy and vigour of their perceptions. Two persons, with equally good eyes, will see the same thing very differently, will have very different perceptions, though the sensations cannot, as far as we can judge, differ in any respect. Let two such persons have a watch placed before each of them as nearly as possible in the same situation in every respect, suppose one minutely acquainted with the beautiful machine and the other unacquainted with it; they have the same sensations, but how different their perceptions; one sees a number of movements, of which he cannot discern the connection, nor point out the part it bears in the performance of the object, the other at once perceives the mutual dependence of the parts and the minutia of the whole structure, its excellences and defects, &c. Our limits will not permit further illustration, but it is in the power of every one to trace it for themselves, by recollecting how differently the same thing appears to different persons of equally vigorous powers of sensation, and how differently it appears to the same person at different times. But all these things do not disprove what we before stated respecting the improvement of the senses themselves; they merely point out as another means to render sensation efficacious, that we should extend the perceptions and render them accurate. That is by giving extent and accuracy to the perceptions we render the sensations more efficacious, which we mentioned as one of the principal things upon which the extent and accuracy of the perceptions depend.—To give vividness and efficacy to the sensations, the organs of sense should then be exerted on various objects and in various situations; a still more important mean is, to direct the attention sufficiently to the objects of sensation. In what manner it produces the effect we know not, but it is certain that the efficaciousness of sensations in producing distinct ideas, depends principally upon the degree of attention which those sensations receive. Hence those who have the care of infants and children, should give them every opportunity to keep their attention directed to the objects of their senses, and every means should be employed to lead them to such attention: a child intently gazing upon an object, or examining it with its little hands and lips, is as usefully employed in the cultivation of intellect as the fondest parent can wish.—There is however more to be done in this connection, also by allowing the child full scope for its own exertions, than by any direct efforts which can be made by others. When its attention is fixed, let it remain so; if possible let the objects of sense be brought under different aspects, and exposed to the different senses. Before words become to a child the sign of voluntary action all that can be done is to expose it to sensations, and to allow them to fix the attention: but afterwards more direct efforts may be made, and the attention may be fixed by various other means than the mere action of the sensations themselves. Independently of its value in providing materials for clear perceptions, it is of peculiar importance to the future improvement of the understanding, and consequently to the moral culture, that the habit of fixed attention should be acquired; and we wish here to express our decided opinion that the character of the intellect and affections, however much it may be modified by future cultivation, receives its stamp from the employment of the first few years of life; that the education of the nursery is of almost incalculable moment in the mental and moral culture; that by the neglect of it years of labour may be rendered requisite to compensate in some degree for it, and by a proper attention to it a foundation is laid for a clear and vigorous understanding and lively and pure affections. As far as the understanding can be considered as separate from the affections, the primary object is to gain clear and extensive perceptions, and fixed active attention; and respecting these, the few observations which have been made may afford some useful hints to the thoughtful. Miss Hamilton has many judicious remarks on this subject at the beginning of the second volume of her work on education; a work which though sometimes incorrect as to scientific arrangement, and still more frequently as to precision of language, contains many highly valuable instructions for the culture of the human mind.

4. Sensations are to be considered not only as the original materials for the various operations of intellect, but as the sources of all the mental pleasures and pains. In the earliest periods of life probably there is no sensation unaccom-

panied either with pleasure or with pain; and as man is constituted, this is necessary both to fix the attention upon the objects of sense, and for self preservation. Pleasurable sensations are called sensible pleasures, painful sensations sensible pains. The pleasurable sensations leave behind them pleasurable ideas, which are called mental or intellectual pleasures, and in the same manner the painful sensations leave behind them painful ideas, which are called mental pains. Mental pleasures combine with one another, and form more complex feelings, and these with others, and so on, till owing to the very great complexity of the whole, the component parts are not discernable. In this stage of their progress it is that they generally fall under our inspection. They appear to us at first to have no connection with sensations, but this is merely because we cannot readily separate them into their component parts. Reasonable evidence can be adduced to show that all the mental pleasures and pains, have their origin, indeed are formed solely, of the relicts of sensible pleasures and pains.

5. Considering sensible pleasures and pains as the rudiments of mental pleasures and pains, it is requisite during the early part of life to keep the inlets of sensation in a fit state for receiving them, and not to check the one or to impose the other, except where an enlightened regard to the future welfare requires it. The health of the body should be attended to, not merely as a means of present and future sensible enjoyment, but as increasing the fund of materials for the purest mental pleasures. Childhood should be regarded as the time for the acquisition of materials, not only for the intellect but for the affections. Its pleasures should be restrained only by those limits which the laws of sensation and association impose, which require that they should be moderate, and connected only with such objects as will not lead to future pains: its unavoidable pains should, as far as possible, be removed, and no avoidable ones imposed, except what the laws of association require, that is, those which are necessary for the removing or preventing of greater evil, either by remedying bodily disorders, and destroying false associations, or by connecting sensible pains with such objects as would lead to future pains, more important either as to vividness or duration.

6. The grand law of sensible pleasures and pains is, that by frequent repetition they lose their vividness. This is a law to which may be traced various important facts connected with the moral culture. Whatever be the peculiar mode by which impressions from the objects of sense are transmitted through the nerves to the brain, it seems decidedly probable that the difference between pleasurable and painful sensations consists (as far as respects the sensations themselves), in degree only that pain has the same cause as pleasure, except that it acts more intensely. "All pleasure," as Hartley remarks, "appears to pass into pain by increasing its cause, impression, duration, sensibility of the organ upon which it is impressed, &c. thus an agreeable warmth may be made to pass into a troublesome or burning heat, by increase or continuance, and the same thing holds with respect to friction, light, and sound." Hence, since repetition diminishes the vividness of the sensation, (provided there be no increase in the exciting cause, or in the sensibility of the organ, &c.) great pain will by repetition gradually subside into pain less intense, pains may be converted by repetition into pleasures, and pleasures may be converted into indifferent sensations. This progress may be observed in the effects of spirituous liquors, or any other stimuli which strongly affect the organs of taste. There are probably no cases in which the taste of spirituous liquors would originally be otherwise than disagreeable, by degrees the repeated use of them brings the sensations which they occasion within the limit of pleasure, even then a considerable increase of the quantity taken would heighten the sensations to the limits of pain: but suppose the pleasurable portion continued without increase, the repeated use of it diminishes the vividness of the pleasure, till at last the sensation produced is completely indifferent.—We here adduce the fact merely as illustrative of the general principle.

7. We have stated in the separate articles above referred to, that the original sensible pleasures derived from the taste and smell are very numerous, and far exceed the pains; that the original sensible pleasures derived from the sight and the hearing are also numerous, while the original sensible pains are few, and that the original sensible pleasures derived from the sense of feeling are less intense than the pains derived from that sense which are more numerous and vivid than all the other sensible pains united. From this account we should be led to infer that the pains of

sensation are very far exceeded by the pleasures of sensation.—This will be still more evident when we recollect that the pleasurable sensations are those of constant occurrence, the painful sensations much more rare. In the early part of life, most sensations that are not painful are pleasurable; and the pleasurable are continually recurring. The eye and the ear seem to convey scarcely any thing but pleasurable sensations to the infant mind; the taste and smell are continually pouring in their pleasurable sensations seldom mixed with pain; the feeling, when the body is healthy, " when life is felt in every limb," is also constantly adding to the stock of pleasurable sensations, those derived from the glow of health and the active motions of childhood; to balance all this there are, in some few cases, frequent pains of body, but more frequently the pains arising from ill health are of seldom recurrence, and the artificial sensible pains are still less frequently received. Such is the matter of fact, and if we consider the cause of the sensible pleasures and pains as differing only in degree, we shall readily admit, that on the whole the pleasurable sensations very far exceed the painful sensations; for the sensible pains being produced by an excessive action of the organs of sensation, common impressions will not produce them, and should they become very frequent by the grand law of sensation already stated, they will gradually diminish in vividness, and at last come within the limits of pleasure.

SENSITIVE *plant*. See MIMOSA.

SENTICOSÆ, in botany, the name of the thirty-fifth order in Linnæus's Fragments of a Natural Method, consisting of the rose, bramble, and other plants that resemble them in external structure.

SEPIA, in natural history, *cuttle-fish*, a genus of the Vermes Mollusca class and order. Body fleshy, receiving the breast in a sheath, with a tubular aperture at its base; eight arms, beset with numerous warts or suckers, and in most species two pedunculated tentacula; head short; eyes large; mouth resembling a parrot's beak. Eight species are mentioned. They inhabit various seas, and in hot climates grow to a very considerable size; they are armed with a most terrible apparatus of holders, furnished with suckers, by which they fasten upon and convey their prey to the mouth.

S. octopus is found in the Mediterranean and Indian Seas, and in the latter it is sometimes so large that the arms are said to be nine fathoms long. In these seas the Indians never venture out without hatchets in their boats, to cut off the arms, should it attempt to fasten upon them and draw them under water.

S. officinalis inhabits the ocean, and is the prey of the whale tribe and plaise; its arms are also frequently eaten off by the conger eel, and are reproduced. See REPRODUCTION. The bony scale on the back is that which is sold in the shops, and which, when reduced to fine powder, is reckoned excellent for the teeth, as well for keeping them white as for preserving them. It is also used as pounce. These animals have the power of squirting out a black fluid resembling ink, which is said to be an ingredient used in the composition of Indian ink. They deposit their eggs upon seaweed, which resemble a bunch of grapes. When first deposited they are white, but when impregnated by the male they become black; they are round, with a little point at the end, and in each of them is inclosed a living cuttle-fish, surrounded with a gelatinous fluid. The flesh is used as food by the Italians.

SEPIARIÆ, in botany, the name of the forty-fourth order in Linnæus's Fragments of a Natural Method, consisting of many beautiful woody plants, both of the shrub and tree kind, most of which do not drop their leaves till nearly the time in which the new leaves begin to appear. Among the plants of this order are the fraxinus, or ash; jasminum, jessamine tree; ligustrum, privet; syringa, lilac.

SEPTAS, in botany, a genus of the Heptandria Heptagynia class and order. Natural order of Succulentæ. Sempervivæ, Jussieu. There is but one species, *viz.* S. capensis, round-leaved septas, a native of the Cape of Good Hope.

SEPTEMBER, the ninth month of the year, consisting of only thirty days: it took its name as being the seventh month, reckoning from March, with which the Romans began their year.

SEPTUAGINT, the name given to a Greek version of the books of the Old Testament, from its being supposed to be performed by seventy-two Jews, who are usually called the seventy interpreters, because seventy is a round number. The history of this version is expressly written by Aristeas, an officer of the guards to Ptolemy Philadelphus, the substance of whose

account is as follows: Ptolemy having erected a fine library at Alexandria, which he took care to fill with the most curious and valuable books from all parts of the world, was informed that the Jews had one containing the laws of Moses, and the history of that people, and being desirous of enriching his library with a Greek translation of it, applied to the high priest of the Jews; and to engage him to comply with his request, set at liberty all the Jews, whom his father Ptolemy Soter had reduced to slavery. After such a step, he easily obtained what he desired; Eleazar, the Jewish high-priest, sent back his embassadors with an exact copy of the Mosaical law, written in letters of gold, and six elders of each tribe, in all seventy-two, who were received with marks of respect by the king, and then conducted into the Isle of Pharos, where they were lodged in a house prepared for their reception, and supplied with every thing necessary in abundance. They set about the translation without loss of time, and finished it in seventy-two days; and the whole being read in the presence of the king, he admired the profound wisdom of the laws of Moses, and sent back the deputies, laden with presents for themselves, the high-priest, and the temple. This version was in use to the time of our Saviour, and is that out of which all the citations in the New Testament, from the Old, are taken. It was also the ordinary and canonical translation made use of by the Christian church in the earliest ages; and it still subsists in the churches both of the east and west. It is, however, observable, that the chronology of the septuagint is different from the Hebrew text.

SEQUENCE, in gaming, a set of cards immediately following each other, in the same suit as a king, queen, knave, &c. and thus we say, a sequence of three, four, or five cards; but at piquet these are called tierces, quarts, quints, &c.

SEQUESTRATION, is the separating or setting aside of a thing in controversy from the possession of both those who contend for it; and it is of two kinds, voluntary or necessary: voluntary is that which is done by consent of each party; necessary is what the judge does of his authority, whether the parties will or not. It is used also for the act of the ordinary disposing of the goods and chattels of one deceased, whose estate no man will meddle with. A sequestration is also a kind of execution for debt, especially in the case of a beneficed clerk, of the profits of the benefice, to be paid over to him that had the judgment till the debt is satisfied.

SEQUIN, a gold coin struck at Venice, and in several parts of the Grand Seignior's dominions.

SERAPIAS, in botany, *helleborine*, a genus of the Gynaudria Diandria class and order. Natural order of Orchideæ. Essential character: nectary ovate, gibbous, with an ovate lip. There are fourteen species.

SERGE, in commerce, a woollen stuff manufactured in a loom, of which there are various kinds, denominated either from their different qualities, or from the places where they are wrought; the most considerable of which is the English serge, which is highly valued abroad, and of which a manufacture had been for some years carried on in France.

In the manufacture of serges, the longest wool is chosen for the warp, and the shortest for the woof. But before either kind is used, it is first scoured, by putting it in a copper of liquor, somewhat more than lukewarm, composed of three parts of fair water and one of urine. After it has staid in it long enough for the liquor to take off the grease, &c. it is stirred briskly about with a wooden peel, taken out, drained, washed in a running water, and dried in the shade; beaten with sticks on a wooden rack, to drive out the coarser dust and filth; and then picked clean with the hands. It is then greased with oil of olives, and the longest wool combed with large combs, heated in a little furnace for that purpose: to clear it from the oil, it is put into a vessel of hot soap-water, whence being taken out, wrung, and dried, it is spun on the wheel. As to the shorter wool, intended for the woof, it is only carded on the knee with small fine cards, and then spun on the wheel, without being scoured of its oil: and here it is to be observed, that the thread for the warp is always to be spun finer, and much better twisted, than that of the woof.

The wool both for the warp and woof being spun, and the thread reeled into skeins; that of the woof is put on spools, fit for the cavity of the shuttle; and that for the warp is wound on a kind of wooden bobbins, to fit it for warping; and when warped, it is stiffened with a size, usually made of the shreds of parchment; and, when dried, put into the loom, and mounted so as to be raised by four treddles, placed under the

loom, which the workman makes to act transversely, equally, and alternately, one after another, with his feet; and as the threads are raised, throws the shuttle. See WEAVING.

The serge, on being taken from the loom, is carried to the fuller, who fulls or scours it, in the trough of his mill, with fullers-earth: and after the first fulling, the knots, ends, straws, &c. sticking out on either side of the surface, are taken off with a kind of pliers, or iron pincers, after which it is returned into the fulling-trough, where it is worked with warm water, in which soap has been dissolved; when quite cleared, it is taken out, the knots are again pulled off; it is then put on the tenter to dry, taking care, as fast as it dries, to stretch it out both in length and breadth, till it be brought to its just dimensions; then being taken off the tenter, it is dyed, shorn, and pressed.

SERJEANT *at law*, is the highest degree taken in that profession, as that of a doctor is in the civil law. To these serjeants, as men of great learning and experience, one court is set apart for them to plead in by themselves, which is the Court of Common Pleas, where the common law of England is most strictly observed; yet, though they have this court to themselves, they are not restrained from pleading in any other courts. The judges cannot be elevated to that dignity till they have taken the degree of Serjeant at Law. They are called brothers by the judges, who hear them next to the King's counsel; but a King's Serjeant has precedence of all but the Attorney and Solicitor General. These are made by the King's mandate, or writ.

SERJEANT *at arms*, is one whose office is to attend on the person of the King, to arrest persons of condition offending.

SERJEANTY, in law, signifies a service that cannot be due from a tenant to any Lord, but to the King only. Although the old tenures are abolished, yet the merely honorary services of grand and petit serjeanty remain.

SERIES, in general, denotes a continued succession of things in the same order, and having the same relation or connection with each other: in this sense we say, a series of emperors, kings, bishops, &c.

In natural history, a series is used for an order or subdivision of some class of natural bodies; comprehending all such as are distinguished from the other bodies of that class, by certain characters, which they possess in common, and which the rest of the bodies of that class have not.

SERIES, in mathematics, is a number of terms, whether of numbers or quantities, increasing or decreasing in a given proportion; the doctrine of which has already been given under the article PROGRESSION.

SERIES, *infinite*, is a series consisting of an infinite number of terms, that is, to the end of which it is impossible ever to come; so that let the series be carried on to any assignable length, or number of terms, it can be carried yet further, without end or limitation.

A number actually infinite, (that is, all whose units can be actually assigned, and yet is without limits) is a plain contradiction to all our ideas about numbers; for whatever number we can conceive, or have any proper idea of, is always determinate and finite; so that a greater after it may be assigned, and a greater after this; and so on, without a possibility of ever coming to an end of the addition or increase of numbers, assignable; which inexhaustibility, or endless progression in the nature of numbers, is all we can distinctly understand by the infinity of number; and therefore to say that the number of any things is infinite, is not saying that we comprehend their number, but indeed the contrary; the only thing positive in this proposition being this, that the number of these things is greater than any number which we can actually conceive and assign. But then, whether in things that do really exist, it can be truly said that their number is greater than any assignable number; or, which is the same thing, that in the numeration of their units one after another, it is impossible ever to come to an end; this is a question about which there are different opinions, with which we have no business in this place; for all that we are concerned here to know, is this certain truth, that after one determinate number, we can conceive a greater, and after this a greater, and so on without end. And, therefore, whether the number of any things that do, or can really exist all at once, can be such that it exceeds any determinable number, or not, this is true, that of things which exist, or are produced successively one after another, the number may be greater than any assignable one; because though the number of things thus produced, that does actually exist at any time, is finite, yet it may be increased without end. And this is the distinct and true

notion of the infinity of a series, that is, of the infinity of the number of its terms, as it is expressed in the definition

Hence it is plain that we cannot apply to an infinite series the common notion of a sum, viz. a collection of several particular numbers that are joined and added together one after another, for this supposes that these particulars are all known and determined, whereas the terms of an infinite series cannot be all separately assigned, there being no end in the numeration of its parts, and therefore it can have no sum in sense But again, if we consider that the idea of an infinite series consists of two parts, viz. the idea of something positive and determined, in so far as we conceive the series to be actually carried on, and the idea of an inexhaustible remainder still behind, or an endless addition of terms that can be made to it one after another, which is as different from the idea of a finite series as two things can be, hence we may conceive it as a whole of its own kind, which, therefore, may be said to have a total value whether that be determinable or not. Now in some infinite series this value is finite or limited, that is, a number is assignable beyond which the sum of no assignable number of terms of the series can ever reach, nor indeed ever be equal to it, yet it may approach to it in such a manner as to want less than any assignable difference; and this we may call the value or sum of the series, not as being a number found by the common method of addition, but as being such a limitation of the value of the series, taken in all its infinite capacity, that if it were possible to add them all one after another, the sum would be equal to this number.

Again, in other series the value has no limitation; and we may express this, by saying, the sum of the series is infinitely great, which, indeed, signifies no more than that it has no determinate and assignable value, and, that the series may be carried such a length as its sum, so far, shall be greater than any given number. In short, in the first case, we affirm there is a sum, yet not a sum taken in the common sense, in the other case, we plainly deny a determinate sum in any sense.

Theorem 1. In an infinite series of numbers, increasing by an equal difference or ratio (that is, an arithmetical or geometrical increasing progression) from a given number, a term may be found greater than any assignable number.

Hence, if the series increase by differences that continually increase, or by ratios that continually increase, comparing each term to the preceding, it is manifest that the same thing must be true, as if the differences or ratios continued equal.

Theorem 2. In a series decreasing in infinitum in a given ratio, we can find a term less than any assignable fraction.

Hence, if the terms decrease, so as the ratios of each term to the preceding do also continually decrease, then the same thing is also true, as when they continue equal.

Theorem 3. The sum of an infinite series of numbers all equal, or increasing continually, by whatever differences or ratios, is infinitely great, that is, such a series has no determinate sum, but grows so as to exceed any assignable number.

Demons. First, if the terms are all equal, as A : A A, &c. then the sum of any finite number of them is the product of A by that number, as A n; but the greater n is, the greater is A n, and we can take n greater than any assignable number, therefore A n will be still greater than any assignable number.

Secondly, suppose the series increases continually, (whether it do so infinitely or limitedly) then its sum must be infinitely great, because it would be so if the terms continued all equal, and therefore will be more so, since they increase. But if we suppose the series increases infinitely, either by equal ratios or differences, or by increasing differences or ratios of each term to the preceding, then the reason of the sums being infinite will appear from the first theorem, for in such a series, a term can be found greater than any assignable number, and much more therefore the sum of that and all the preceding.

Theorem 4. The sum of an infinite series of numbers decreasing in the same ratio is a finite number, equal to the quote arising from the division of the product of the ratio and first term, by the ratio less by unity; that is, the sum of an assignable number of terms of the series can ever be equal to that quote; and yet no number less than it is equal to the value of the series, or to what we can actually determine in it; so that we can carry the series so far, that the sum shall want of this quote less than any assignable difference.

Demons. To whatever assigned number of terms the series is carried, it is so far finite, and if the greatest term is l, the least

A, and the ratio r, then the sum is $S = \frac{rl - A}{r - 1}$. See PROGRESSION.

Now, in a decreasing series from l, the more terms we actually raise, the last of them, A, becomes the lesser, and the lesser A is $rl - A$ is the greater, and so also is $\frac{rl - A}{r - 1}$: but $rl - A$ being still less than rl, therefore $\frac{rl - A}{r - 1}$ is still less than $\frac{rl}{r - 1}$, that is, the sum of any assignable number of terms of the series is still less than the quote mentioned, which is $\frac{rl}{r - 1}$, and this is the first part of the theorem.

Again, the series may be actually continued so far, that $\frac{rl - A}{r - 1}$ shall want of $\frac{rl}{r - 1}$ less than any assignable difference; for, as the series goes on, A becomes less and less in a certain ratio, and so the series may be actually continued till A becomes less than any assignable number, (by Theorem 2) now $\frac{rl}{r - 1} - \frac{rl - A}{r - 1} = \frac{A}{r - 1}$, and $\frac{A}{r - 1}$ is less than A; therefore let any number assigned be called N, we can carry the series so far till the last term A be less than N; and because $\frac{rl - A}{r - 1}$ wants of $\frac{rl}{r - 1}$, the difference $\frac{A}{r - 1}$, which is less than A, which is also less than N, therefore the second part of the theorem is also true, and $\frac{rl}{r - 1}$ is the true value of the series.

Scholium. The sense in which $\frac{rl}{r - 1}$ is called the sum of the series, has been sufficiently explained; to which, however, we shall add this, that whatever consequences follow from the supposition of $\frac{rl}{r - 1}$ being the true and adequate value of the series taken in all its infinite capacity, as if the whole were actually determined and added together, can never be the occasion of any assignable error in any operation or demonstration where it is used in that sense; because if it is said that it exceeds that adequate value, yet it is demonstrated that this excess must be less than any assignable difference, which is in effect no difference, and so the consequent error will be in effect no error: for if any error can happen from $\frac{rl}{r - 1}$ being greater than it ought to be, to represent the complete value of the infinite series, that error depends upon the excess of $\frac{rl}{r - 1}$ over that complete value; but this excess being unassignable, that consequent error must be so too; because still the less the excess is, the less will the error be that depends upon it. And for this reason we may justly enough look upon $\frac{rl}{r - 1}$ as expressing the adequate value of the infinite series. But we are further satisfied of the reasonableness of this, by finding, in fact, that a finite quantity does actually convert into an infinite series, which happens in the case of infinite decimals. For example, $\frac{2}{3} = .6666$, &c. which is plainly a geometrical series from $\frac{6}{10}$ in the continual ratio of 10 to 1; for it is $\frac{6}{10} + \frac{6}{100} + \frac{6}{1000} + \frac{6}{10000}$, &c.

And reversely, if we take this series, and find its sum by the preceding theorem, it comes to the same $\frac{2}{3}$; for $l = \frac{6}{10}$, $r = 10$, therefore $rl = \frac{60}{10} = 6$; and $r - 1 = 9$; whence $\frac{rl}{r - 1} = \frac{6}{9} = \frac{2}{3}$.

We have added here a table of all the varieties of determined problems of infinite, decreasing, geometrical progressions, which all depend upon these three things, *viz.* the greatest term l, the ratio r, and the sum by any two of which the remaining one may be found: to which we have added some other problems, wherein $S - L$ is considered as a thing distinct by itself, that is, without considering S and L separately.

Given.	Sought.			Solutions.
$r\ l$	s,	$s=\frac{rl}{r-1}$	Or supposing the ratio $\frac{a}{b}$ or the second term to be M, whereby the ratio is $\frac{l}{M}$, then is	$s=\frac{a}{a-b}$ of $l=\frac{ll}{l-M}$
$r\ s$	l,	$l=\frac{s\times\overline{r-1}}{r}$		$l=\frac{a-b}{a}$ of $s=\frac{\overline{l-M}\times s}{l}$
$l\ s$	r,	$r=\frac{}{s-l}\Big\}$		$s-l=\frac{b}{a-b}$ of $l=\frac{Ml}{l-M}$
$l\ r$	$s-l$,	$s-l=\frac{l}{r-1}$		
$s\ r$	$s-l$,	$s-l=\frac{s}{r}$		$s-l=\frac{b}{a}$ of $s=\frac{Ms}{l}$
$r.\ s-l$	$s,\ l$	$\left\{\begin{matrix} s=\overline{s-l}\times r \\ l=\overline{s-l}\times\overline{r-1}\end{matrix}\right\}$		$s=\frac{a}{b}$ of $s-l=\frac{l\times\overline{s-l}}{M}$ $l=\frac{a-b}{b}$ of $s-l=\frac{\overline{l-M}\times\overline{s-l}}{M}$

Theorem 5. In the arithmetic progression 1, 2, 3, 4, &c. the sum is to the product of the last term, by the number of terms, that is, to the square of the last term; in a ratio always greater than 1 : 2, but approaching infinitely near it. But if the arithmetical series begins with 0, thus, 0, 1, 2, 3, 4, &c. then the sum is to the product of the last term, by the number of terms, exactly in every step as 1 to 2.

Theorem 6. Take the natural progression beginning with 0, thus, 0, 1, 2, 3, &c. and take the squares of any the like powers of the former series, as the squares, 0, 1, 4, 9, &c. or cubes, 0, 1, 8, 27; and then again take the sum of the series of powers to any number of terms, and also multiply the last of the terms summed by the number of terms, (reckoning always 0 for the first term) the ratio of that sum, to that product is more than $\frac{1}{n\times 1}$ (n being the index of the powers), that is, in the series of squares it is more than $\frac{1}{3}$; in the cubes more than $\frac{1}{4}$; and so on: but the series going on in infinitum, we may take in more and more terms without end into the sum; and the more we take, the ratio of the sum to the product mentioned grows less and less; yet so as it never can actually be equal to $\frac{1}{n\times 1}$ but approaches infinitely near to it, or within less than any assignable difference.

"The nature, origin, &c. of series." Infinite series commonly arise, either from a continued division, or the extraction of roots, as first performed by Sir I. Newton, who also explained other general ways for the expanding of quantities into infinite series, as by the binomial theorem. Thus, to divide 1 by 3, or to expand the fraction $\frac{1}{3}$ into an infinite series; by division in decimals in the ordinary way, the series is 0.3333, &c. or $\frac{3}{10}+\frac{3}{100}+\frac{3}{1000}+\frac{3}{10000}$, &c. where the law of continuation is manifest. Or, if the same fraction $\frac{1}{3}$ be set in this form $\frac{1}{2+1}$, and division be performed in the algebraic manner, the quotient will be

$$\frac{1}{3}=\frac{1}{2+1}=\frac{1}{2}-\frac{1}{4}+\frac{1}{8}-\frac{1}{16}+\frac{1}{32}, \text{ \&c.}$$

Or, if it be expressed in this form $\frac{1}{3}=\frac{1}{4-1}$, by a like division there will arise the series,

$$\frac{1}{3}=\frac{1}{4}+\frac{1}{16}+\frac{1}{64}, \text{ \&c.}=\frac{1}{4}+\frac{1}{4^2}+\frac{1}{4^3}, \text{ \&c.}$$

And, thus, by dividing 1 by 5 — 2, or 6 — 3, or 7 — 4, &c. the series answering to the fraction $\frac{1}{3}$, may be found in an endless variety of infinite series; and the finite quantity $\frac{1}{3}$ is called the value or radix of the series, or also its sum, being the number or sum to which the series would amount, or the limit to which it would tend or approximate, by summing up its terms, or by collecting them together one after another. In like man-

ner, by dividing 1 by the algebraic sum $a+c$, or by $a-c$, the quotient will be in these two cases, as below, *viz.*

$$\frac{1}{a+c}=\frac{1}{a}-\frac{c}{a^2}+\frac{c^2}{a^3}-\frac{c^3}{a^4}, \text{ \&c.}$$
$$\frac{1}{a-c}=\frac{1}{a}+\frac{c}{a^2}+\frac{c^2}{a^3}+\frac{c^3}{a^4}, \text{ \&c.}$$

where the terms of each series are the same, and they differ only in this, that the signs are alternately positive and negative in the former, but all positive in the latter.

And hence, by expounding a and c by any numbers whatever, we obtain an endless variety of infinite series, whose sums or values are known. So, by taking a or c equal to 1, or 2, or 3, or 4, &c. we obtain these series, and their values;

$$\frac{1}{1+1}=\frac{1}{2}=1-1+1-1+1-1, \text{ \&c.}$$
$$\frac{1}{3-1}=\frac{1}{2}=\frac{1}{3}+\frac{1}{3^2}+\frac{1}{3^3}+\frac{1}{3^4}, \text{ \&c.}$$
$$\frac{1}{2+1}=\frac{1}{3}=\frac{1}{2}-\frac{1}{2^2}+\frac{1}{2^3}-\frac{1}{2^4}, \text{ \&c.}$$
$$\frac{1}{1+2}=\frac{1}{3}=1-2+2^2-2^3, \text{ \&c.}$$
$$\frac{1}{3+1}=\frac{1}{4}=\frac{1}{3}-\frac{1}{3^2}+\frac{1}{3^3}-\frac{1}{3^4}, \text{ \&c.}$$

And hence it appears, that the same quantity or radix may be expressed by a great variety of infinite series, or that many different series may have the same radix, or sum.

Another way in which an infinite series arises, is by the extraction of roots. Thus, by extracting the square root of the number 3 in the common way, we obtain its value in a series as follows, *viz.* $\sqrt{3}=1{\cdot}73205$, &c. $=1+\frac{7}{10}+\frac{3}{100}+\frac{2}{1000}+\frac{5}{100000}$, &c.; in which way of resolution the law of the progression of the series is not visible, as it is when found by division. And the square root of the algebraic quantity a^2+c^2 gives

$$\sqrt{a^2+c^2}=a+\frac{c^2}{2a}-\frac{c^4}{8a^3}+\frac{c^6}{16a^5}, \text{ \&c.}$$

And a 3d way is by Newton's binomial theorem, which is an universal method, that serves for all sorts of quantities, whether fractional or radical ones: and by this means the same root of the last given quantity becomes $\sqrt{a^2+c^2}=$

$$a+\frac{c^2}{2a}-\frac{1.\ c^4}{2.4\ a^3}+\frac{1.3\ c^6}{2.4.6\ a^5}+\frac{1.3.5\ c^8}{2.4.6.8\ a^7},$$

&c. where the law of continuation is visible.

Hence it appears that the signs of the terms may be either all plus, or alternately plus and minus, though they may be varied in many other ways. It also appears that the terms may be either continually smaller and smaller, or larger and larger, or else all equal. In the first case, therefore, the series is said to be a *decreasing* one; in the 2d case, an *increasing* one; and in the 3d case, an *equal* one. Also the first series is called a *converging* one, because that by collecting its terms successively, taking in always one term more, the successive sums approximate or converge to the value or sum of the whole infinite series. So, in the series

$$\frac{1}{3-1}=\frac{1}{2}=\frac{1}{3}+\frac{1}{9}+\frac{1}{27}+\frac{1}{81}, \text{ \&c.}$$

the first term $\frac{1}{3}$ is too little, or below $\frac{1}{2}$, which is the value or sum of the whole infinite series proposed; the sum of the first two terms $\frac{1}{3}+\frac{1}{9}$ is $\frac{4}{9}={\cdot}4444$, &c. is also too little, but nearer to $\frac{1}{2}$ or $\cdot5$ than the former; and the sum of three terms $\frac{1}{3}+\frac{1}{9}+\frac{1}{27}$ is $\frac{13}{27}={\cdot}481481$, &c. is nearer than the last, but still too little; and the sum of four terms

$\frac{1}{3}+\frac{1}{9}+\frac{1}{27}+\frac{1}{81}$ is $\frac{40}{81}={\cdot}493827$, &c.

which is again nearer than the former, but still too little; which is always the case when the terms are all positive. But when the converging series has its terms alternately positive and negative, then the successive sums are alternately too great and too little, though still approaching nearer and nearer to the final sum or value. Thus, in the series

$$\frac{1}{3+1}=\frac{1}{4}=0{\cdot}25=\frac{1}{3}-\frac{1}{9}+\frac{1}{27}-\frac{1}{81}, \text{ \&c.}$$

the 1st term $\frac{1}{3}={\cdot}333$, &c. is too great;

two terms $\frac{1}{3}-\frac{1}{9}={\cdot}222$, &c. are too little;

three terms $\frac{1}{3}-\frac{1}{9}+\frac{1}{27}={\cdot}259259$, &c. are too great;

four terms $\frac{1}{3}-\frac{1}{9}+\frac{1}{27}-\frac{1}{81}={\cdot}246913$, &c. are too great, and so on, alternately, too great and too small, but every succeeding sum still nearer than the former, or converging.

In the second case, or when the terms

grow larger and larger, the series is called a *diverging* one, because that by collecting the terms continually, the successive sums diverge, or go always further and further from the true value or radix of the series; being all too great when the terms are all positive, but alternately too great and too little when they are alternately positive and negative. Thus, in the series

$$\frac{1}{1+2}=\frac{1}{3}=1-2+4-8, \text{ \&c.}$$

the first term $+1$ is too great;
two terms $1-2=-1$ are too little;
three terms $1-2+4=+3$ are too great;
four terms $1-2+4-8=-5$ are too little; and so on, continually, after the 2d term, diverging more and more from the true value or radix $\frac{1}{3}$, but alternately too great and too little, or positive and negative. But the alternate sums would be always more and more too great if the terms were all positive, and always too little if negative.

But in the third case, or when the terms are all equal, the series of equals, with alternate signs, is called a *neutral* one, because the successive sums, found by a continual collection of the terms, are always at the same distance from the true value or radix, but alternately positive and negative, or too great and too little. Thus, in the series

$$\frac{1}{1+1}=\frac{1}{2}=1-1+1-1+1-1, \text{ \&c.}$$

the first term 1 is too great;
two terms $1-1=0$ are too little;
three terms $1-1+1=1$ too great;
four terms $1-1+1-1=0$ too little;
and so on, continually, the successive sums being alternately 1 and 0, which are equally different from the true value, or radix, $\frac{1}{2}$, the one as much above it as the other below it.

A series may be terminated and rendered finite, and accurately equal to the sum or value, by assuming the supplement, after any particular term, and combining it with the foregoing terms. So, in the series $\frac{1}{2}-\frac{1}{4}+\frac{1}{8}-\frac{1}{16}$, &c. which is equal to $\frac{1}{3}$, and found by dividing 1 by $2+1$, after the first term, $\frac{1}{2}$, of the quotient, the remainder is $-\frac{1}{2}$, which, divided by $2+1$, or 3, gives $-\frac{1}{6}$ for the supplement, which, combined with the first term, $\frac{1}{2}$, gives $\frac{1}{2}-\frac{1}{6}=\frac{1}{3}$, the true sum of the series. Again, after the first two terms $\frac{1}{2}-\frac{1}{4}$, the remainder is $+\frac{1}{4}$, which, divided by the same divisor, 3, gives $\frac{1}{12}$ for the supplement, and this combined with those two terms $\frac{1}{2}-\frac{1}{4}$, makes $\frac{1}{2}-\frac{1}{4}+\frac{1}{12}=\frac{1}{4}+\frac{1}{12}=\frac{4}{12}$ or $\frac{1}{3}$ the same sum or value as before. And, in general, by dividing 1 by $a+c$, there is obtained

$$\frac{1}{a+c}=\frac{1}{a}-\frac{c}{a^2}+\frac{c^2}{a^3}\dots\pm\frac{c^n}{a^{n+1}}\mp\frac{c^{n+1}}{a^{n+1}(a+c)};$$

where, stopping the division at any term, as $\frac{c^n}{a^{n+1}}$, the remainder after this term is $\frac{c^{n+1}}{a^{n+1}}$, which, being divided by the same divisor, $a+c$, gives $\frac{c^{n+1}}{a^{n+1}(a+c)}$ for the supplement as above.

"The Law of Continuation."—A series being proposed, one of the chief questions concerning it is to find the law of its continuation. Indeed, no universal rule can be given for this; but it often happens, that the terms of the series, taken two and two, or three and three, or in greater numbers, have an obvious and simple relation, by which the series may be determined and produced indefinitely. Thus, if 1 be divided by $1-x$, the quotient will be a geometrical progression, *viz.* $1+x+x^2+x^3$, &c. where the succeeding terms are produced by the continual multiplication by x. In like manner, in other cases of division, other progressions are produced.

But in most cases, the relation of the terms of a series is not constant, as it is in those that arise by division. Yet their relation often varies according to a certain law, which is sometimes obvious on inspection, and sometimes it is found by dividing the successive terms one by another, &c. Thus, in the series

$$1+\frac{2}{3}x+\frac{8}{15}x^2+\frac{16}{35}x^3+\frac{128}{315}x^4, \text{ \&c.}$$

by dividing the 2d term by the 1st, the 3d by the 2d, the 4th by the 3d, and so on, the quotients will be

$$\frac{2}{3}x,\ \frac{4}{5}x,\ \frac{6}{7}x,\ \frac{8}{9}x,\ \&c.;$$

and therefore the terms may be continued indefinitely by the successive multiplication by these fractions. Also in the following series

$$1+\frac{1}{6}x+\frac{3}{40}x^2+\frac{5}{128}x^3+\frac{35}{1152}x^4,\ \&c.$$

by dividing the adjacent terms successively by each other, the series of quotients is

$$\frac{1}{6}x,\ \frac{9}{20}x,\ \frac{25}{42}x,\ \frac{49}{72}x,\ \&c.;\ \text{or}$$

$$\frac{1.1}{2.3}x,\ \frac{3.3}{4.5}x,\ \frac{5.5}{6.7}x,\ \frac{7.7}{8.9}x,\ \&c.;$$

and therefore the terms of the series may be continued by the multiplication of these fractions.

SERIES, *summation of.* We have before seen the method of determining the sums of quantities in arithmetical and geometrical progression, but when the terms increase, or decrease, according to other laws, different artifices must be used, to obtain general expressions for their sum.

The methods chiefly adopted, and which may be considered as belonging to algebra, are, 1. The method of subtraction. 2. The summation of recurring series, by the scale of relation. 3. The differential method. 4. The method of increments. We shall content ourselves with an example or two, in the first of these methods.

"The investigation of series, whose sums are known by subtraction."

Ex. 1. Let $1+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+$, &c. in inf. $=S$,

then $\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+$, &c. in inf. $=S-1$,

by subtraction, $\frac{1}{1.2}+\frac{1}{2.3}+\frac{1}{3.4}+$, &c. in inf. $=1$; or $\frac{1}{2}+\frac{1}{6}+\frac{1}{12}+\frac{1}{20}$, &c. $=1$.

Ex. 2. Let $1+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+$, &c. in inf. $=S$.

then $\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\frac{1}{6}+$, &c. in inf. $=S-\frac{3}{2}$,

by subtraction, $\frac{2}{1.3}+\frac{2}{2.4}+\frac{2}{3.5}+\frac{2}{4.6}+$ &c. in inf. $=\frac{3}{2}$;

or $\frac{1}{1.3}+\frac{1}{2.4}+\frac{1}{3.5}+\frac{1}{4.6}+$, &c. in inf. $=\frac{3}{4}$.

Ex. 3. Let $\frac{1}{1.2}+\frac{1}{2.3}+\frac{1}{3.4}+$, &c. in inf. $=S$,

then $\frac{1}{2.3}+\frac{1}{3.4}+\frac{1}{4.5}+$, &c. in inf. $=S-\frac{1}{2}$,

by subtraction, $\frac{2}{1.2.3}+\frac{2}{2.3.4}+\frac{2}{3.4.5}+$, &c. in inf. $=\frac{1}{2}$,

and $\frac{1}{1.2.3}+\frac{1}{2.3.4}+\frac{1}{3.4.5}+$, &c. in inf. $=\frac{1}{4}$.

Ex. 4. Let $\frac{1}{m}+\frac{1}{m+r}+\frac{1}{m+2r}+\ldots\ldots \frac{1}{m+\overline{n-1}.r}+\frac{1}{m+nr}=S$,

then $\frac{1}{m+r}+\frac{1}{m+2r}+\frac{1}{m+3r}+\ldots\ldots \frac{1}{m+nr}=S-\frac{1}{m}$,

by subtraction, $\frac{r}{m.\overline{m+r}}+\frac{r}{\overline{m+r}.\overline{m+2r}}+$ &c. (to n terms) $+\frac{1}{m+nr}=\frac{1}{m}$;

hence, $\frac{r}{m.\overline{m+r}}+\frac{r}{\overline{m+r}.\overline{m+2r}}+$ &c. (to n terms) $=\frac{1}{m}-\frac{1}{m+nr}$,

and $\frac{1}{m.\overline{m+r}}+\frac{1}{\overline{m+r}.\overline{m+2r}}+$, &c. (to n terms) $=\frac{1}{mr}-\frac{1}{mr+nr^2}$.

If n be increased without limit, $\frac{1}{mr+nr^2}$ vanishes, and the sum of the series is $\frac{1}{mr}$.

If $m=r=1$, we have $\frac{1}{1.2}+\frac{1}{2.3}+\frac{1}{3.4}+$, &c. (to n terms) $=1-\frac{1}{1+n}=\frac{n}{1+n}$.

Similar to the method of subtraction is the following, given by De Moivre.

"Assume a series, whose terms converge to o, involving the powers of an indeterminate quantity, x; call the sum of the series S, and multiply both sides of the equation by a binomial, trinomial, &c. which involves the powers of x, and invariable coefficients; then, if x be so assumed that the binomial, trinomial, &c. may vanish, and some of the first terms be transposed, the

sum of the remaining series is equal to the terms so transposed."

Let $1+\frac{x}{2}+\frac{x^2}{3}+\frac{x^3}{4}+$, &c. in inf. $=S$.

Multiplying both sides by $x-1$, we have

$$\left.\begin{array}{l} x+\frac{x^2}{2}+\frac{x^3}{3}+\frac{x^4}{4}+\text{, \&c.} \\ -1-\frac{x}{2}-\frac{x^2}{3}-\frac{x^3}{4}-\frac{x^4}{5}-\text{, \&c.} \end{array}\right\} = \overline{x-1}\,.\,S$$

or $-1+\frac{x}{1.2}+\frac{x^2}{2.3}+\frac{x^3}{3.4}+$, &c. $=$ $\overline{x-1}\,.\,S$; and if $x=1$,

then, $-1+\frac{1}{1.2}+\frac{1}{2.3}+\frac{1}{3.4}+$, &c. $=0$; or, $\frac{1}{1.2}+\frac{1}{2.3}+\frac{1}{3.4}+$, &c. in inf. $=1$.

SERIOLA, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semiflosculosæ. Cichoraceæ, Jussieu. Essential character: calyx, simple; pappus subplumose; receptacle chaffy. There are four species.

SERIPHIUM, in botany, a genus of the Syngenesia Polygamia Segregata class and order. Natural order of Compositæ Nucamentaceæ. Corymbiferæ, Jussieu. Essential character: calyx, imbricate; corolla, one petalled, regular, seed one; oblong, below the corolla. There are four species, all natives of the Cape of Good Hope.

SERPENTINE, in mineralogy, a species of the Talc genus: divided by Werner into the common and precious: the common is chiefly green, though passing into various other colours, which are seldom uniform. There are generally several colours together, and these are arranged in striped, dotted, and clouded delineations. It occurs massive: internally it is faintly glimmering, which passes into dull when there are no foreign particles to give a slight degree of lustre. It is soft, not very brittle, and frangible. Feels a little greasy, not very heavy. It is infusible before the blow-pipe without addition. It consists of

Magnesia	23
Silica	45
Alumina	18
Iron	3
Water	12
	101

It is one of the primitive rocks: is found in many parts of Germany, Italy, Siberia, in this country, Scotland, and the Shetland islands. It takes a good polish, and is turned into vessels and ornaments of a great variety of shapes. In upper Saxony, several hundred people are employed in quarrying, cutting, turning, and polishing the serpentine which occurs in that neighbourhood, and the articles into which it is manufactured are carried all over Germany. The precious is found in Silesia.

SERPICULA, in botany, a genus of the Monoecia Tetrandria class and order. Natural order of Inundatæ. Onagræ, Jussieu. Essential character: male, calyx, four-toothed; corolla, four petalled; female, calyx, four-parted; pericarpium, nut tomentose. There are two species, viz. S. verticillata and S. repens.

SERPULA, in natural history, a genus of the Vermes Testacea class and order: animal a terebella: shell univalve, generally adhering to other substances: often separated internally by divisions at uncertain distances. About fifty species have been enumerated.

SERPENTES, in natural history, an order of the Amphibia, containing seven genera: viz.

Achrochordus	Cœcilia
Amphisbæna	Coluber
Anguis	Crotalus.
Boa	

Serpents are distinguished as footless amphibia: their eggs are connected in a chain: penis frequently double: they breathe through the mouth. The amphibia were divided by Linnæus into four orders; viz. Reptilia, Serpentes, Meantes, and Nantes. Of the meantes or gliders, which were characterized as breathing by means of gills and lungs together: feet branchiated and furnished with claws: there was but a single genus, viz. the siren: this has since been classed with the reptiles. See REPTILIA and SIREN.

The nantes, or swimming amphibia, characterized by their having fins; and by breathing by means of lateral gills, were afterwards distributed into the orders of fishes denominated branchiostigi, and chondropterygii, which have since been ranked by Dr. Shaw and others under the general term cartilaginous fishes. See CHRONDROPTERIGIOUS.

We have thought it right to give this account of the changes in the Linnæan system, which we have generally adopted, having omitted any mention of the facts under the former articles. "Serpents," says the trans-

lator of Gmelin, "are cast naked upon the earth, without limbs, exposed to every injury, but frequently armed with a poison, the most deadly and horrible: this is contained in tubular fangs resembling teeth, placed without the upper jaw, protruded or retracted at pleasure, and surrounded with a glandular vesicle by which this fatal fluid is secreted: but lest this tribe should too much encroach upon the limits of other animals, the benevolent Author of nature has armed about a fifth part only in this dreadful manner, and has ordained that all should cast their skins, in order to inspire a necessary suspicion of the whole. The jaws are dilatable, and not articulate, and the œsophagus so lax that they can swallow, without any mastication, an animal twice or thrice as large as the neck: the colour is variable, and changes according to the season, age, or mode of living, and frequently vanishes, or turns to another in the dead body: tongue filiform, bifid; skin reticulate." The distinction between the poisonous and innoxious serpents, is only to be known by an accurate examination of their teeth; those which are poisonous being always tubular, and calculated for the injection of the poisonous fluid, from a peculiar reservoir communicating with the fang on each side the head. These teeth or fangs are situated in the upper jaw: they are frequently accompanied by smaller fangs, seemingly intended to supply the place of the others, if lost by age or accident. The fangs are situated in a peculiar bone, so articulated with the rest of the jaw as to elevate or depress them at the pleasure of the animal: in a quiescent state they are recumbent, with their points directed inwards or backwards; but when the animal is inclined to use them as weapons of offence, their position is altered by the peculiar mechanism of the bone in which they are rooted, and they become almost perpendicular.

Serpents in cold and temperate climates conceal themselves during winter, in cavities beneath the surface of the ground, or in any other convenient places of retirement, where they become nearly or wholly in a state of torpidity. Some serpents are viviparous, as the rattle-snake; the viper, &c.: while the innoxious species are oviparous, depositing, as we have observed, their eggs in a kind of chain in any warm and close situation, where they are afterwards hatched. The broad undivided laminæ on the bellies of serpents, are termed scuta, and the smaller or divided ones beneath the tail are called subcaudal scales, and from these different kinds of laminæ, the Linnæan genera are characterized.

SERRATULA, in botany, *saw-wort*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Capitatæ. Cinarocephalæ, Jussieu. Essential character: calyx, subcylindrical, imbricate, awnless. There are twenty species.

SERROPALPUS, in natural history, a genus of insects of the order Coleoptera: antennæ setaceous; four feelers unequal; the anterior ones longer, deeply serrate, composed of four joints, the last joint very large, truncate, compressed, patelliform; the posterior one subclavate; thorax margined, concealing the head, with a prominent angle on each side; head deflected; feet formed for digging. There are two species, *viz.* S. striatus, which is of a brown colour, with striated shells, found in autumn in old buildings: S. lævigatus, which is black and smooth.

SERTULARIA, in natural history, a genus of the Vermes Zoophyta class and order: animal growing in the form of a plant; stem branched, producing polypes, from cup-shaped denticles or minute cells. Nearly fourscore species have been enumerated. These are divided into two classes: A. stem horny, tubular, fixed by the base, beset with cup-shaped denticles, and furnished with vesicles or ovaries containing polypes, eggs, or the living young. B. stem crustaceous, inclining to stone, and composed of rows of cells: there are no vesicles, but in the place of them are small globules.

SERUM. See Blood.

SESAMUM, in botany, *sesamum* or *oilygrain*, a genus of the Didynamia Angiospermia class and order. Natural order of Luridæ. Bignoniæ, Jussieu. Essential character: calyx five-parted; corolla bell-shaped, five-cleft, the lower lobe larger; rudiment of a fifth filament; stigma lanceolate; capsule four-celled. There are three species, *viz.* the orientale, the indicum, and the luteum. S. orientale has ovate, oblong, entire leaves. It is an annual, and grows naturally on the coast of Malabar and in the island of Ceylon; rising with an herbaceous four-cornered stalk, two feet high, sending out a few short side branches. After the flowers are past, the germen turns to an oval acute pointed capsule, with four cells, filled with oval compressed seeds, which

ripen in autumn. S. indicum, with trifid lower leaves, grows naturally in India; this is also an annual plant, the stalk rises taller than that of the former, the lower leaves are cut into three parts, which is the only difference between them. The first sort is frequently cultivated in all the eastern countries, and also in Africa, as a pulse; and of late years the seeds have been introduced into Carolina by the African negroes, where they succeed extremely well. The inhabitants of that country make an oil from the seed, which will keep good for many years, without having any rancid smell or taste, but in two years become quite mild; so that when the warm taste of the seed, which is in the oil when first drawn, is worn off, they use it as a salad-oil, and for all the purposes of sweet oil. The seeds of this plant are also used by the negroes for food; which seeds they parch over the fire, and then mix them with water, and stew other ingredients with them, which makes a hearty food.

SESELI, in botany, *meadow saxifrage*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ or Umbelliferæ. Essential character: umbels globular, involucre of one or two leaflets; fruit ovate, striated. There are fifteen species.

SESSIONS *of the peace*. See Quarter *Sessions*.

SESUVIUM, in botany, a genus of the Icosandria Trigynia class and order. Natural order of Succulentæ. Ficoidæ, Jussieu. Essential character: calyx five parted, coloured, petals none, capsule ovate, three-celled, cut round, many-seeded. There is only one species, *viz*. S. portulacastrum, a native of the West Indies.

SET *off*, in law, is when the defendant acknowledges the justice of the plaintiff's demand on the one hand, but on the other sets up a demand of his own, to counterbalance that of the plaintiff, either in the whole or in part, as if the plaintiff sue for 10*l*. due on a note of hand, the defendant may set off 9*l*. due to himself for merchandise sold to the plaintiff, or for any other demand, the amount of which is ascertained in damages.

The action in which a set off is allowable upon the statutes 2 and 3 George II. c. 22 and 24, are debt, covenant, and assumpsit, for the non-payment of money; and the demand intended to be set off must be such as might have been made the subject of one or other of these actions. A set off, therefore, is never allowed in actions upon the case, trespass, replevin, &c.; nor of a penalty in debt on bond conditioned for the performance of covenants, &c. nor of general damages in covenant or assumpsit: but where a bond is conditioned for the payment of an annuity, a set off may be allowed. A debt barred by the statute of limitations cannot be set off; and if it be pleaded in bar to the action, the plaintiff may reply the statute of limitations, or if given in evidence, on a notice of set off, which is one mode of setting up this sort of counter-demand, it may be objected to at the trial.

SET, or Sets, a term used by the farmers and gardeners to express the young plants of the white thorn and other shrubs, with which they use to raise their quick or quickset hedges.

SETON, in surgery, a few horse hairs, small threads, or large packthread drawn through the skin, chiefly the neck, by means of a large needle or probe, with a view to restore or preserve health.

SETTE, a vessel very common in the Mediterranean, with one deck, and a very long and sharp prow: they carry some two masts, some three, without top masts. Their yards and sails are all like the mizen; the least of them are of sixty tons burden. They serve to transport cannon and provision for ships of war, and the like.

SETTING, in astronomy, the withdrawing of a star or planet, or its sinking below the horizon. Astronomers and poets make three different kinds of setting of the stars, *viz*. the cosmical, acronychal, and helical.

Setting, in the sea language. To set the land or the sun, by the compass, is to observe how the land bears on any point of the compass, or on what point of the compass the sun is. Also, when two ships sail in sight of one another, to mark on what point the chased bears, is termed setting the chase by the compass.

SEWER, in the household, an officer who comes in before the meat of a king or nobleman, to place and range it on the table.

Sewer is also a passage or gutter made to carry water into the sea or a river, whereby to preserve the land, &c. from inundations and other annoyances. The business of the commissioners of sewers, or their office in particular, is to repair sea-banks and walls, survey rivers, public streams, ditches, &c. and to make orders for that purpose. These commission-

ers have likewise authority to make inquiry of all nuisances or offences committed by the stopping of rivers, erecting mills, not repairing banks, bridges, &c. and to tax persons chargeable for the amending of defaults that tend to the obstruction or hindrance of the free passage of the water through its ancient courses. They may not only make a rate and assessment for repairs, but also may decree lands to be sold, in order to levy charges assessed upon nonpayment thereof, &c. But the decrees of the commissioners are to be certified in Chancery, and have the King's assent to be binding, and their proceedings are subject to the jurisdiction of the King's Bench. In the making of a rate or tax, the commissioners are to assess every owner or possessor of lands in danger of receiving any damage by the waters, equally according to the quality of their lands, rents, and numbers of acres, and their respective portions and profits, whether it be of pasture, fishing, &c. And where no persons or lands can be known that are liable to make repairs of banks and sewers, then the commissioners are to rate the whole level. The 3 James I. ordains that all ditches, banks, bridges, and water-houses, within two miles of London, adjoining to, and falling into the Thames, shall be subject to the commissioners of sewers. Also the Lord Mayor, &c. may appoint persons in that case to have the power of commissioners of sewers. Persons breaking down sea-banks, whereby lands are damaged, are adjudged to be guilty of felony; and removing piles, &c. forfeit 20*l.* by 6 and 10 George II. c. 32.

SEX, something in the body which distinguishes male from female.

SEXAGENARY, something relating to the number sixty. Thus, sexagenary, or sexagesimal arithmetic, is a method of computation proceeding by sixties; such is that used in the division of a degree into sixty minutes, of the minute into sixty seconds, of the second into sixty thirds, &c. Also sexagenary tables are tables of proportional parts, showing the product of two sexagenaries that are to be multiplied, or the quotient of the two that are to be divided.

SEXAGESIMALS, or SEXAGESIMAL *fractions*, fractions whose denominators proceed in a sexagecuple ratio; that is, a prime, or the first minute $= \frac{1}{60}$; a second $= \frac{1}{3600}$; a third $= \frac{1}{216000}$.

Anciently there were no other than sexagesimals used in astronomy, and they are still retained in many cases, though decimal arithmetic has now grown into use in astronomical calculations. In these fractions, which some call astronomical fractions, the denominator being always sixty, or a multiple thereof, is usually omitted, and the numerator only written down, thus, $4^{\circ}, 59', 32'', 50''', 16''''$, is to be read four degrees, fifty-nine minutes, thirty-two seconds, fifty thirds, sixteen fourths, &c.

SEXANGLE, in geometry, a figure having six sides, and consequently six angles.

SEXTANS, a sixth part of certain things. The Romans having divided their *as* into twelve ounces, or *unica*, the sixth part of that, or two ounces, was the sextans. Sextans was also a measure which contained two ounces of liquor, or two cyathi.

SEXTANT, in mathematics, denotes the sixth part of a circle, or an arch comprehending sixty degrees. The word sextant is more particularly used for an astronomical instrument made like a quadrant, excepting that its limb only comprehends sixty degrees. The use and application of the sextant is the same with that of the quadrant. See QUADRANT.

SEXTILE, the position or aspect of two planets when at sixty degrees distance, or at the distance of two signs from one another. It is marked thus (*).

SEXTON, a church officer, whose business is to take care of the vessels, vestments, &c. belonging to the church, and to attend the minister, churchwardens, &c. at church. He is usually chosen by the parson only. The office of sexton, in the Pope's chapel, is appropriated to the order of the hermits of St. Augustine. He is generally a bishop, though sometimes the Pope only gives a bishopric in particular to him on whom he confers the post: he takes the title of prefect of the Pope's sacristy, and has the keeping of the vessels of gold and silver, the relics, &c. When the pope says mass, the sexton always tastes the bread and wine first. If it be in private he says mass, his Holiness of two wafers gives him one to eat; and if in public, the cardinal who assists the Pope in quality of deacon, of three wafers gives him one to eat. When the Pope is very sick, he administers to him the sacrament of extreme unction, &c. and enters the conclave in quality of first conclavist.

SEXUAL *system*, in botany, that system of classification which was invented by the immortal Linnæus, professor of physic and botany, at Upsal, in Sweden. It is founded on the parts of fructification, viz. the sta-

mens and pistils; these having been observed with more accuracy since the discovery of the uses for which nature has assigned them, a new set of principles have been derived from them, by means of which the distribution of plants has been brought to a greater precision, and rendered more conformable to true philosophy, in this system, than in any one of those which preceded it. The author does not pretend to call it a natural system, he gives it as artificial only, and modestly owns his inability to detect the order pursued by nature in her vegetable productions; but of this he seems confident, that no natural order can ever be framed without taking in the materials out of which he has raised his own; and urges the necessity of admitting artificial systems for convenience, till one truly natural shall appear. Linnæus has given us his "Fragmenti Methodi Naturalis," in which he has made a distribution of plants under various orders, putting together in each such as appear to have a natural affinity to each other; this, after a long and fruitless search after the natural method, he gives as the result of his own speculation, for the assistance of such as may engage in the same pursuit hereafter. Not finding it practicable to form a system after the natural method, Linnæus was more fully convinced of the absolute necessity of adopting an artificial one, of which a detailed account is given under the article BOTANY.

SHAD, in ichthyology, a species of Clupea, with the upper jaw bifid at the extremity, and spotted with black; it greatly resembles the common herring, and is, on that account, sometimes called the mother of herring; all the fins are whitish, except that on the back; the tail is very much forked.

SHADOW, in optics, a privation or diminution of light, by the interposition of an opaque body; or it is a plane where the light is either altogether obstructed, or greatly weakened, by the interposition of some opaque body between it and the luminary. A shadow of itself is invisible; and therefore, when we say we see a shadow, we partly mean that we see bodies placed in the shadow, and illuminated by light reflected from collateral bodies; and, partly, that we see the confines of the light. If the opaque body that projects the shadow be perpendicular to the horizon, and the place it is projected on be horizontal, the shadow is called a right shadow; and such are the shadows of men, trees, buildings, mountains, &c. But if the opaque body be placed parallel to the horizon, the shadow is called a versed shadow; as the arms of a man stretched out, &c.

"The laws of the projection of Shadows from opaque bodies." 1. Every opaque body projects a shadow in the same direction with its rays; that is, towards the part opposite to the light. Hence, as either the luminary or the body changes place, the shadow likewise changes. 2. Every opaque body projects as many shadows as there are luminaries to enlighten it. 3. As the light of the luminary is more intense, the shadow is the deeper: hence the intensity of the shadow is measured by the degrees of light that space is deprived of. 4. If a luminous sphere be equal to an opaque one it illuminates, the shadow, which this latter projects, will be a cylinder, and consequently will be propagated still equal to itself, to whatever distance the luminary is capable of acting; so that if it be cut in any place, the plane of the section will be a circle, equal to a great circle of the opaque sphere. 5. If the luminous sphere be greater than the opaque one, the shadow will be conical. If, therefore, the shadow be cut by a plane, parallel to the base, the plane of section will be a circle; and that so much the less as it is a greater distance from the base. 6. If the luminous sphere be less than an opaque one, the shadow will be a truncated cone; and, consequently, grows still wider and wider; and therefore, if cut by a plane parallel to the section, that plane will be a circle, so much the greater as it is further from the base.

The sun being vastly larger than the whole globe of the earth must give all its shadows pointed, by reason that it illumines more than half of them. In consequence of this demonstration we might conclude, that all the sun's shadows must be less than the bodies that project them, and diminished more and more as they recede further and further. Now this would be true were there any relation between the body illuminated and the body illumining; but as all objects on the earth are so small in comparison of that star, the diminution of their shadows is imperceptible to the eye, which sees them always equal; *i. e.* either broader or narrower than the body that forms them: on this account all the shadows caused by the sun are made in parallels. From the whole it appears, that to find the shadow of any body whatever

opposed to the sun, a line must be drawn from the top of the luminary perpendicular to the place where the foot of the luminary is to be taken: and through this place an occult line is to be drawn through one of the angles of the plan of the object, and another from the sun to the same angle; and the intersection of the two lines will show how far the shadow is to go: all the other lines must be drawn parallel hereto. The shadows of the sun are equal in objects of the same height, though at a distance from each other. Experience teaches, that stiles, or elevations of the same height, removed to a distance from each other, do yet project equal shadows at the same time: for they are lengthening and shortening, in proportion as the sun comes nearer, or recedes further off; one or other of which he is continually doing.

Shadow, in geography. The inhabitants of the terraqueous globe of the earth receive different denominations, according to the different ways wherein their shadows are projected; as ascii, amphiscii, heteroscii, and periscii.

Shadow, in painting, an imitation of a real shadow, effected by gradually heightening and darkening the colours of such figures as by their dispositions cannot receive any direct rays from the luminary that is supposed to enlighten the piece. The management of the shadows and lights makes what the painters call claro-obscuro.

SHAFT *of a column*, in building, is the body thereof between the base and capital: so called from its straightness. The term shaft is also used for the spire of a church steeple, and for the tunnel of a chimney. See Architecture.

Shaft, in mining, is the pit or hollow entrance into the mine.

SHAGREEN, or Chagreen, in commerce, a kind of grained leather, prepared, as is supposed, of the skin of a species of squalus, or hound-fish, called the shagree, or shagrain, and much used in covering cases, books, &c. It is imported from Constantinople, Tauris, Tripoli, Algiers, and from some parts of Poland, where it is prepared in the following manner: the skin being stretched out, is first covered over with mustard seed, which is bruised upon it: and being thus exposed to the weather for some days, it is then tanned. The best is of a brownish colour, as the white sort is the worst: it is extremely hard; yet, when steeped in water, it becomes soft and pliable; and being fashioned into case-covers, it readily takes any colour, as red, green, yellow, black, according to the fancy of the workman.

SHAMBLES, among miners, a sort of niches, or landing places, left at such distances in the adits of mines, that the shovelmen may conveniently throw up the ore from shamble to shamble, till it comes to the top of the mine.

SHAMMY, or Chamois *Leather*, a kind of leather, dressed either in oil or tanned; and much esteemed for its softness, pliancy, and being capable of bearing soap without hurt. The true shammy is prepared of the skin of the chamois-goat. See Capra.

The true chamois leather is counterfeited with common goat, kid, and even sheepskin; the practice of which makes a particular profession, called by the French chamoisure. The last is the least esteemed, yet so popular, and such vast quantities prepared, especially about Orleans, Marseilles, and Thoulouse, that it may not be amiss to give the method of preparation.

"The manner of chamoising, or of preparing sheep, goat, or kid-skins in oil, in imitation of chamois." The skins being washed, drained, and smeared over with quick-lime on the fleshy side, are folded in two, lengthwise, the wool outwards, and laid on heaps, and so left to ferment eight days; or, if they had been left to dry after flaying, for fifteen days. Then they are washed out, drained, and half-dried, laid on a wooden leg or horse, the wool stripped off with a round staff for the purpose, and laid in a weak pit, the lime whereof had been used before, and had lost the greatest part of its force. After twenty-four hours they are taken out, and left to drain twenty-four more; then put in another strong pit. This done, they are taken out, drained, and put in again by turns; which begins to dispose them to take oil: and this practice they continue for six weeks in summer, or three months in winter; at the end whereof they are washed out, laid on the wooden leg, and the surface of the skin on the wool side peeled off, to render them the softer; then, made into parcels, steeped a night in the river; in winter, more; stretched six or seven over one another, on the wooden leg; and the knife passed strongly on the flesh side, to take off any thing superfluous, and render the skin smooth. Then they are stretched as before, in the river, and the same operation repeated on the wool side; then thrown into a tub of water with bran in it, which is

brewed among the skins till the greatest part stick to them, and then separated into distinct tubs, till they swell and rise of themselves above the water. By this means the remains of the lime are cleared out: they are then wrung out, hung up to dry on ropes, and sent to the mill, with the quantity of oil necessary to scour them: the best oil is that of stock fish. Here they are first thrown in bundles into the river for twelve hours, then laid in the mill trough, and fulled without oil till they be well softened, then oiled with the hand, one by one, and thus formed into parcels of four skins each, which are milled and dried on chords a second time, then a third, then oiled again and dried.

This process is repeated as often as necessity requires, when done, if there be any moisture remaining, they are dried in a stove, and made up into parcels wrapped up in wool, after some time they are opened to the air, but wrapped up again as before, till such time as the oil seems to have lost all its force, which it ordinarily does in twenty-four hours.

The skins are then returned from the mill to the chamoiser to be scoured, which is done by putting them into a lixivium of wood ashes, working and beating them in it with poles, and leaving them to steep till the lye have had its effect; then wrung out, steeped in another lixivium, wrung again, and this repeated till all the grease and oil be purged out. They are then half dried, and passed over a sharp-edged iron instrument, placed perpendicular in a block, which opens, softens, and makes them pliable: lastly, they are thoroughly dried, and passed over the same instrument again, which finishes the preparation, and leaves them in form of shammy.

Kid and goat skins are chamoised in the same manner as those of sheep, excepting that the hair is taken off without the use of any lime, and that when brought from the mill they undergo a particular preparation called ramalling, the most delicate and difficult of all the others. It consists in this, that as soon as brought from the mill they are steeped in a fit lixivium: taken out, stretched on a round wooden leg, and the hair scraped off with the knife; this makes them smooth, and, in working, cast a fine nap. The difficulty is in scraping them evenly.

SHARK, in ichthyology, the English name of two species of squalus, distinguished by their different colours, blue and white. See SQUALUS.

SHARP (ABRAHAM), in biography, an eminent mathematician, mechanist, and astronomer, was descended from an ancient family at Little Horton, near Bradford, in the west riding of Yorkshire, where he was born about the year 1651. At a proper age he was put apprentice to a merchant at Manchester, but his genius led him so strongly to the study of mathematics, both theoretical and practical, that he soon became uneasy in that situation of life. By the mutual consent, therefore, of his master and himself, though not altogether with that of his father, he quitted the business of a merchant. Upon this he removed to Liverpool, where he gave himself up wholly to the study of mathematics, astronomy, &c. and where for a subsistence he opened a school, and taught writing and accounts, &c.

He had not been long at Liverpool, when he accidentally fell in company with a merchant, or tradesman, visiting that town from London, in whose house it seems the astronomer Flamsteed then lodged. With the view, therefore, of becoming acquainted with this eminent man, Mr. Sharp engaged himself with the merchant as a book keeper. In consequence he soon contracted an intimate acquaintance and friendship with Mr. Flamsteed, by whose interest and recommendation he obtained a more profitable employment in the dock-yard at Chatham; where he continued till his friend and patron, knowing his great merit in astronomy and mechanics, called him to his assistance in contriving, adapting, and fitting up the astronomical apparatus in the royal observatory at Greenwich, which had been lately built, namely, about the year 1676, Mr. Flamsteed being then thirty years of age, and Mr. Sharp twenty five.

In this situation he continued to assist Mr. Flamsteed in making observations (with the mural arch, of eighty inches radius, and 140 degrees on the limb, contrived and graduated by Mr. Sharp) on the meridional zenith distances of the fixed stars, Sun, Moon, and planets, with the time of their transit over the meridian, also the diameter of the Sun and Moon, and their eclipses, with those of Jupiter's satellites, the variation of the compass, &c. He assisted him also in making a catalogue of nearly 3000 fixed stars, as to their longitudes and magnitudes, their right ascensions and polar distances, with

the variations of the same while they change their longitude by one degree.

But from the fatigue of continually observing the stars at night, in a cold thin air, joined to a weakly constitution, he was reduced to a bad state of health; for the recovery of which he desired leave to retire to his house at Horton; where, as soon as he found himself on the recovery, he began to fit up an observatory of his own, having first made an elegant and curious engine for turning all kinds of work in wood or brass, with a maundril for turning irregular figures, as ovals, crosses, wreathed pillars, &c. Beside these, he made himself most of the tools used by joiners, clock-makers, opticians, mathematical instrument-makers, &c. The limbs, or arcs, of his large equatorial instrument, sextant, quadrant, &c. he graduated with the nicest accuracy, by diagonal divisions into degrees and minutes. The telescopes he made use of were all of his own making, and the lenses ground, figured, and adjusted with his own hands.

It was at this time that he assisted Mr. Flamsteed in calculating most of the tables in the second volume of his "Historia Cœlestis," as appears by their letters, to be seen in the hands of Mr. Sharp's friends at Horton. Likewise the curious drawings of the charts of all the constellations visible in our hemisphere, with the still more excellent drawings of the planispheres both of the northern and southern constellations. And though these drawings of the constellations were sent to be engraved at Amsterdam by a masterly hand, yet the originals far exceeded the engravings in point of beauty and elegance; these were published by Mr. Flamsteed, and both copies may be seen at Horton.

The mathematician meets with something extraordinary in Sharp's elaborate "Treatise of Geometry Improved," (in 4to. 1717, signed A. S. Philomath), 1st. by a large and accurate table of segments of circles, its construction, and various uses in the solution of several difficult problems, with compendious tables for finding a true proportional part, and their use in these or any other tables exemplified in making logarithms, or their natural numbers, to 60 places of figures, there being a table of them for all primes to 1100, true to 61 figures. 2d. His concise "Treatise of Polyedra," or solid bodies of many bases, both the regular ones and others: to which are added twelve new ones, with various methods of forming them, and their exact dimensions in surds or species, and in numbers: illustrated with a variety of copper-plates, neatly engraved by his own hands. Also the models of these polyedra he cut out in box-wood with amazing neatness and accuracy. Indeed few or none of the mathematical instrument-makers could exceed him in exactly graduating or neatly engraving any mathematical or astronomical instrument, as may be seen in the equatorial instrument above mentioned, or in his sextant, quadrants, and dials of various sorts; also in a curious armillary sphere, which, beside the common properties, has moveable circles, &c. for exhibiting and resolving all spherical triangles; also his double sector, with many other instruments, all contrived, graduated, and finished, by himself. In short, he possessed at once a remarkably clear head for contriving, and an extraordinary hand for executing any thing, not only in mechanics; but likewise in drawing, writing, and making the most exact and beautiful schemes or figures, in all his calculations and geometrical constructions.

The quadrature of the circle was undertaken by him for his own private amusement in the year 1699, deduced from two different series, by which the truth of it was proved to 72 places of figures; as may be seen in the introduction to Sherwin's table of logarithms; that is, if the diameter of the circle be 1, the circumference will be found equal to 3,141592653589793238462643383279502884197169399375105820974944592307816405, &c. In the same book of Sherwin's may also be seen his ingenious improvements on the making of logarithms, and the constructing of the natural sines, tangents, and secants.

He also calculated the natural and logarithmic sines, tangents, and secants, to every second in the first minute of the quadrant: the laborious investigation of which may probably be seen in the archives of the Royal Society, as they were presented to Mr. Patrick Murdock for that purpose; exhibiting his very neat and accurate manner of writing and arranging his figures, not to be equalled perhaps by the best penman now living.

The late ingenious Mr. Smeaton says, (Philosophical Transactions, anno 1786, p. 5, &c.): "In the year 1689, Mr. Flamsteed completed his mural arc at Greenwich; and, in the Prolegomena to his Historia Cœlestis, he makes an ample acknow-

ledgment of the particular assistance, care, and industry of Mr. Abraham Sharp; whom, in the month of August 1688, he brought into the observatory as his amanuensis; and being, as Mr. Flamsteed tells us, not only a very skilful mathematician, but exceedingly expert in mechanical operations, he was principally employed in the construction of the mural arc; which in the compass of fourteen months he finished, so greatly to the satisfaction of Mr. Flamsteed, that he speaks of him in the highest terms of praise.

"This celebrated instrument, of which he also gives the figure at the end of the Prolegomena, was of the radius of 6 feet, 7½ inches; and, in like manner as the sextant was furnished both with screws and diagonal divisions, all which were made by the accurate hand of Mr. Sharp. But yet, whoever compares the different parts of the table for conversion of the revolutions, and parts of the screw belonging to the mural arc, into degrees, minutes, and seconds, with each other, at the same distance from the zenith on different sides; and with their halves, quarters, &c. will find as notable a disagreement of the screw-work from the hand divisions, as had appeared before in the work of Mr. Tompion: and hence we may conclude, that the method of Dr. Hook, being executed by two such masterly hands as Tompion and Sharp, and found defective, is in reality not to be depended upon in nice matters.

"From the account of Mr. Flamsteed it appears also, that Mr. Sharp obtained the zenith point of the instrument, or line of collimation by observation, of the zenith stars, with the face of the instrument on the east and on the west side of the wall; and that having made the index stronger (to prevent flexure) than that of the sextant, and thereby heavier, he contrived, by means of pulleys and balancing weights, to relieve the hand that was to move it from a great part of its gravity. Mr. Sharp continued in strict correspondence with Mr. Flamsteed as long as he lived, as appeared by letters of Mr. Flamsteed's, found after Mr. Sharp's death, many of which I have seen.

"I have been the more particular in what relates to Mr. Sharp, in the business of constructing this mural arc, not only because we may suppose it the first good and valid instrument of the kind, but because I look upon Mr. Sharp to have been the first person that cut accurate and delicate divisions upon astronomical instruments, of which, independently of Mr. Flamsteed's testimony, there still remain considerable proofs; for, after leaving Mr. Flamsteed, and quitting the department above mentioned, he retired into Yorkshire, to the village of Little Horton, near Bradford, where he ended his days about the year 1743 (should be in 1742), and where I have seen not only a large and very fine collection of mechanical tools, the principal ones being made with his own hands, but also a great variety of scales and instruments made with them, both in wood and brass, the divisions of which were so exquisite, as would not discredit the first artist of the present times; and I believe there is now remaining a quadrant, of four or five feet radius, framed of wood, but the limb covered with a brass plate, the subdivisions being done by diagonals, the lines of which are as finely cut as those upon the quadrants at Greenwich. The delicacy of Mr. Sharp's hand will indeed permanently appear from the copper-plate, in a quarto book, published in the year 1718, intituled 'Geometry Improved, by A. Sharp, Philomath,' (or rather 1717, by A. S. Philomath) whereof not only the geometrical lines upon the plates, but the whole of the engraving of letters and figures were done by himself, as I was told by a person in the mathematical line, who very frequently attended Mr. Sharp in the latter part of his life. I therefore look upon Mr. Sharp as the first person that brought the affair of hand division to any degree of perfection."

Mr. Sharp kept up a correspondence by letters with most of the eminent mathematicians and astronomers of his time, as Mr. Flamsteed, Sir Isaac Newton, Dr. Halley, Dr. Wallis, Mr. Hodgson, Mr. Sherwin, &c. the answers to which letters are all written upon the backs or empty spaces of the letters he received, in a short hand of his own contrivance. From a great variety of letters (of which a large chest-full remains with his friends); from these and many other well known facts it is evident that Mr. Sharp spared neither pains nor time to promote real science. Indeed, being one of the most accurate and indefatigable computers that ever existed, he was for many years the common resource for Mr. Flamsteed, Sir Jonas Moore, Dr. Halley, and others, in all sorts of troublesome and delicate calculations.

Mr. Sharp continued all his life a bachelor, and spent his time as recluse as a her-

mit. He was of a middle stature, but very thin, being of a weakly constitution; he was remarkably feeble the last three or four years before he died, which was on the eighteenth of July, 1742, in the ninety-first year of his age.

In his retirement at Little Horton, he employed four or five rooms or apartments in his house for different purposes, into which none of his family could possibly enter at any time without his permission. He was seldom visited by any persons, except two gentlemen of Bradford, the one a mathematician, and the other an ingenious apothecary: these were admitted when he chose to be seen by them, by the signal of rubbing a stone against a certain part of the outside wall of the house. He duly attended the dissenting chapel at Bradford, of which he was a member, every Sunday, at these times he took care to be provided with plenty of halfpence, which he very charitably suffered to be taken singly out of his hand, held behind him during his walk to the chapel, by a number of poor people who followed him, without his ever looking back, or asking a single question.

Mr. Sharp was very irregular as to his meals, and remarkably sparing in his diet, which he frequently took in the following manner: A little square hole, something like a window, made a communication between the room where he was usually employed in calculations, and another chamber or room in the house where a servant could enter; and before this hole he had contrived a sliding board: the servant always placed his victuals in this hole, without speaking or making the least noise, and when he had a little leisure he visited his cupboard to see what it afforded to satisfy his hunger or thirst. But it often happened that the breakfast, dinner, and supper have remained untouched by him when the servant has gone to remove what was left, so deeply engaged had he been in calculations. Cavities might easily be perceived in an old English oak table where he sat to write, by the frequent rubbing and wearing of his elbows. *Gutta cavat lapidem*, &c. By Mr. Sharp's epitaph it appears that he was related to Archbishop Sharp; and Mr. Sharp, the eminent surgeon, who some years since retired from business, is the nephew of our author. Another nephew was the father of Mr. Ramsden, the present celebrated instrument maker, who says that his grand uncle Abraham, our author, was some time, in his younger days, an exciseman, which occupation he quitted on coming to a patrimonial estate of about two hundred pounds a year.

SHASTER, or SHASTRAM, a sacred book, containing the religion of the Banians; it consists of three tracts; the first of which contains their moral law; the second, the ceremonial; and the third, delivers the peculiar observances for each tribe of Indians.

SHAWIA, in botany, so named in memory of Thomas Shaw, D.D. a genus of the Syngenesia Polygamia Segregata class and order. Essential character: calyx imbricate, with five or six scales, three interior longer; corolla five-cleft; seed one, oblong. There is only one species, *viz.* S. paniculata, a native of New Zealand.

SHEADING, a term used in the Isle of Man for a riding, tything, or division of that isle; the whole being divided into six of these sheadings; in each of which there is a coroner or constable, who is appointed by the delivery of a rod at the tinewald court, or annual convention.

SHEATHING, in ship-building, a sort of casing or covering nailed all over the outside of a ship's bottom, to protect the planks from the pernicious effects of the worms. It has been customary many years past to sheath the ships of the Royal Navy, and those of the East India service with copper.

SHEAVE, or SHEEVE, in maritime affairs, the wheel on which the rope works in a block; it is generally formed of lignum-vitæ, sometimes of brass, and frequently compounded of both: the interior part, or that which sustains the friction against the pin, being of brass, let into the exterior, which is of lignum-vitæ; it is then denominated a sheave with a brass bush.

SHEAVE *hole*, is a channel cut in a mast, yard, or timber, in which to fix a sheave, and answering instead of a block.

SHEEP, in zoology, a well-known genus of quadrupeds, the horns of which are hollow, bent backward, twisted, and rugose; the fore-teeth are eight, and the hinder ones are narrower than the others; there are no canine, or dog-teeth. See OVIS.

SHEEP. Any person who shall feloniously drive away, or feloniously steal any sheep or lamb, or wilfully kill any sheep or lamb, with a felonious intent to steal the carcase, or any part thereof, or assist or aid in committing any of the said offences, shall be guilty of felony, without benefit of clergy. 14 George II. c. 6. Any person who shall

apprehend and prosecute to conviction any such offender, shall have a reward of 10*l.*; for which purpose he shall have a certificate signed by the judge, before the end of the assizes, certifying such conviction, and where the offence was committed, and that the offender was apprehended and prosecuted by the person claiming the reward; and if more than one claim it, he shall therein appoint what share shall be paid to each claimant. And on tendering such certificate to the sheriff, he shall pay the same within a month, without deduction, or forfeit double, with treble costs, to be allowed in his accounts, or be repaid him out of the Treasury. And any person who shall in the night time maliciously and wilfully maim, wound, or otherwise hurt any sheep, whereby the same is not killed, shall forfeit to the party grieved treble damages, by action of trespass, or on the case.

By 28 George III. c. 38, every person who shall export any live sheep or lambs, shall forfeit 3*l.* for every sheep or lamb, and shall also suffer solitary imprisonment for three months, without bail, and until the forfeiture is paid, but not to exceed twelve months for such non-payment; and for every subsequent offence 5*l.* a piece, and imprisonment for six months, and until the forfeiture be paid, but not to exceed two years for the non-payment thereof. And all ships and vessels employed in the exportation of sheep shall be forfeited.

SHEEP *shank*, in naval affairs, a kind of knot made on a rope to shorten it, and is particularly used on runners or ties, to prevent the tackle from coming block and block. By this contrivance, the body to which the tackle is applied may be hoisted much higher, or removed further, in a shorter time.

SHEERING, or SHEARING, in the woollen manufacture, is the cutting off, with large sheers, the too long nap, in order to make the cloth more smooth and even.

SHEERING, in the sea language, when a ship is not steered steadily, they say she sheers, or goes sheering, or, when at anchor, she goes in and out, by means of the current of the tide, they also says she sheers.

SHEERS, in naval affairs, an engine used to hoist in, or get out the lower masts of a ship. They are either placed on the side of a quay or wharf, or are fixed on board of an old ship cut down, or, lastly, they are composed of two masts, or large spars lashed together, and erected in the vessel in which the mast is to be placed or displaced, the lower ends of the props resting on the opposite sides of the deck, and the upper parts being fastened together across, from which a tackle depends.

SHEET, in naval affairs, a rope fastened to one or both of the lower corners of a sail, to extend and retain it in a particular situation. When a ship sails with a side wind, the lower corners of the main and fore-sails are fastened by a tack and sheet, the former being to windward, and the latter to leeward: the tack is, however, only diffused with a stern wind, whereas the sail is never spread without the assistance of one or both of the sheets. The stay sails and studding-sails have only one tack and one sheet each, the stay-sails tack are fastened forward, and the sheets drawn aft, but the studding-sail tacks draw the outer corner of the sail to the extremity of the boom, while the sheet is employed to extend the inner corner.

SHEFFIELDIA, in botany, so named in honour of Mr. Sheffield, an eminent botanist of the University of Oxford, a genus of the Pentandria Monogynia class and order. Natural order of Caryophyllei. Lysimachiæ, Jussieu. Essential character: calyx five-cleft; corolla bell-shaped; filaments ten, the alternate ones barren, capsule one celled, five-valved, many seeded. There is only one species, viz. S. repens, a native of New Zealand and Easter Island.

SHEKEL, in Jewish antiquity, an ancient coin, worth about 2*s.* 3½*d.* sterling.

SHELF, among miners, the same with what they otherwise call fast ground, or fast country; being that part of the internal structure of the earth which they find lying even, and in an orderly manner, and, evidently having retained its primitive form and situation, unmoved by the waters of the general deluge, while the circumjacent, and upper strata, have plainly been removed and tossed about.

SHELL, a substance of a stony hardness, composed of carbonate of lime variously combined with animal gluten, and serving for the coverings and habitations of different animals, mostly of the order of Mollusca; allowing of the occasional protrusion of part of their naked body. The various forms, the beautiful colours, and the high polish which shells possess, have long rendered them objects of research to the curious naturalist: many of them, possessing these properties in a high degree, and

being from their rarity purchased at very high prices.

The vast variety of forms which shells possess, not only renders arrangement more necessary, but at the same time occasions the formation of that arrangement the more difficult. Dissimilarity in size and colour, as well as in form, which occur in shells of the same species, at different ages, adds much to this difficulty. External characters, however, sufficiently marking specific differences, may almost always be discovered in shells, at every period of their existence; and various attempts have hence been made, to dispose them in such a methodical arrangement, as should place each of them in its proper place; and should thereby occasion them to be more readily recollected.

Lister, Langius, and other early writers on testaceology, have proposed different methodical arrangements of shells, which, from their imperfections, have been intirely laid aside, and do not therefore require to be here noticed. Indeed it appears to be unnecessary to go further back than to the arrangement of the celebrated Linnæus, which seems, in its turn, to be yielding to later systems, rendered more perfect by the constant accession of new and illustrative specimens, and the consequent increase of knowledge. But previous to considering the proper method of arrangement, and to examining into even the generic differences, it will be proper to ascertain the characters which belong to shells in general, and to determine the precise terms by which they can be best expressed.

The division into univalves, bivalves, and multivalves is so clearly pointed out by nature, that it must be adopted in every well methodized arrangement, and may therefore be safely admitted in these preliminary observations. Univalve shells are discoidal when the spiral is formed on a horizontal line, so that a section, made in that line, would divide the shell into two nearly equal parts; fusiform when it bulges in the middle, and has the two extremities of nearly equal length; turbinated, when the belly of the shell is very large and tumid compared with the spire, which is given off from its centre; and turriculated when the turns of the spire, gradually increasing, form an elongated cone.

The parts of univalve shells are, the back, which is the external bulging part of the turn opposite to the opening; the belly, the tumid part of the last turn, forming the right or outer lip; that being termed the left which is formed on the columella, and which Linnæus distinguished as the columellar ridge. The spire is formed on the superior part of the shell, the turns of which are formed round the columella, or little central column, reaching from the opening of the shell to the summit of the spire. These convolutions are numbered by reckoning that as one, which reaches from the external to the inner lip, and in the same manner to the summit; the line by which they are united being termed a suture. The spire itself is either pointed, obtuse, truncated, flattened, concave, convex, straight, oblique, or pyramidal. Its turnings are coronated, (beset with spines or tubercles), beaded, carinated, or canaliculated. The suture is crenulated, double, projecting, or effaced. The shell is said to be perforated, when a small umbilical cavity exists in the columella at the base of the shell, in the axis round which the spire is revolved; and imperforate when there is here no cavity nor umbilicus. Besides being either umbilicated or not, the columella may be flattened, truncated, caudated, canaliculated, spiral, and plaited, as in the Volutes. The umbilicus also may be slit, canaliculated, consolidated, crenulated, or dentated: it may also have a superadded cullus. The opening varies much in different shells; and where it narrows it acquires the name of throat; it terminates in a canal. The lip is eared, digitated, alated, grooved, slit, or wrinkled; the form of the opening depending much on that of the lip; it hence becoming angular, round, semicircular, longitudinal, transverse, linear, gaping, compressed, or reversed. The openings of shells are sometimes closed by a shelly or cartilaginous plano-convex body, termed operculum, which is disposed between the two lips, and fitted to the form of the opening. The flat surface of this body is marked by a spiral line.

A bivalve shell has the two valves, which constitute it, connected at the basis, or inferior margin; opposite to which is the superior margin; the shell being supposed to be placed on the hinge, its margin is divided into the anterior and the posterior margin. The length of the shell is measured from the inferior to the superior margin, and the breadth from the anterior to the posterior margin. The belly is the most tumid part, and the beaks, the prominences over the hinge, are of a conoidal and spiral form. At the basis of the shell is the hinge, by which the valves are moved on each other; and in the anterior chink a

ligament is placed, by which the valves are closely connected. This chink is formed by a slight separation of the valves at this, the anterior, part, which having a distinct surface from the general disc, and being indeed separated from it by an angle, or by a raised or sunk line, it may be distinguished as the corslet: this surface is particularly distinguished in the shells of the Venus kind. On these parts, in some species, are spines, in others various markings, and in others, these parts are plain. At the lower part of the anterior margin of the valves, within the limits of the corslet, and above the ligament, is a part generally distinguishable from the rest of the surface by a difference in the colour, striæ, &c. This part varies in its form, being canaliculated, replicated, &c. Its edges are termed lips.

On the other side of the hinge, on the posterior part, and near to the hinge, is generally a lunated depression; the crescent, like the part just described, it varies in its form and markings in different shells. Both these parts derive half their form from each of the valves; and are consequently separated in the middle. To determine the side to which a valve belongs, the shell need only be placed on the hinge with the anterior side forward, when it directly shows itself.

In some irregular shells, as of oysters and Spondyles, the shells are divided into upper and under, the upper shell being flatter than the under. In the Terebratulæ, the upper shell, the beak of which is pierced, is more tumid than the under: but in most shells, as in the Pectens, and the oysters, the upper valve is almost always the least tumid.

The hinge is, in general, furnished with teeth; but sometimes it is without. When placed on the side, they are said to be lateral; and when on the inferior extremity, terminal. The central teeth, essential to the genus, are termed the cardinal teeth; and the others, accessory or secondary. The teeth are in some shells articulated, in a cavity, in the opposite valve; in others, they are not. In multivalves also the shell is the combination of all the valves, whether connected by articulation, or by ligaments.

From the observations and experiments of Reaumur, which have been since considerably extended by Bruguiere and others, the formation and growth of shells have obtained considerable illustration. Leuwenhoeck, Swammerdam, Lister, and others, had observed, that, at the first escape of the animal from the egg, it was invested by a complete spiral turn, at least, of the shell; and, it appears, from the observations of Adanson, that viviparous shell fish are likewise brought forth in a similar state. The growth of shells was discovered by Reaumur to take place in that which is most distant from the first formed part. Here a part of the animal exists which is not yet covered with shell; but which is beset with a vast number of vessels, which separate and deposit, on the existing edge of the shell, those glutinous and calcareous matters, by which its due increased extent of surface is obtained. In proof of this being the process by which the augmentation of the shell is effected, he broke the shells of various living testaceous animals in different parts, and was thus enabled to perceive, that the newly added matter was not deposited line after line from the shell, at the edges of the fractured part; but was separated, in a pellicle, from the body of the animal, and thus applied at once to the whole of the vacuity. Those, who denied this mode of increase, denied also the removal of the posterior termination of the worm, from the extreme termination of the first formed spire. But it is certain that the animal, in many shells, have their posterior termination attached to the point of the shell only in their earliest stages; and that, when older, it is found adherent to the second or third turn: and it has also been ascertained that the tail of the Nerite is attached beneath the left or columellar lip. In proof of these animals possessing this power of removing themselves from these turns of the shell, or indeed from those parts in which their residence is no longer necessary, the circumstance may be adduced of the animal belonging to the Porcellanea, sometimes abandoning its old shell, and forming a new one.

The various tints of different colours with which shells are so beautifully adorned, result, according to the remarks of the same ingenious naturalist, from an œconomy and organization somewhat similar to that which has been just mentioned. On the neck of the animal, that part from which the matter of the shell is supposed to be secreted, the colours of the shell may be detected. Thus if the ground of the shell be yellow, and it be marked with dark brown or black bands, then the neck of the animal will be seen of a white inclining to a yellow hue, with dark spots, answering in their number and direction to the bands observable in the

shell itself: the colouring matter appearing to be here disposed, ready for its deposition, with the other substances of the shell. In this manner, and on these principles, has Reaumur been able to explain almost every circumstance, respecting the varieties of form and of colour which are observable in these bodies.

But a circumstance is observable in the Olives and the Porcellaneæ, to which Reaumur has not attempted to apply his doctrine. In these shells the colours are disposed in two layers, the outer of which is the production of an organization different from that of any of the other inhabitants of shells, and from which proceeds an operation, also different from what occurs in any other instance. At the period at which Reaumur wrote, several of the olives and of the cowries, in consequence of certain differences of colour, and of some difference also in their forms, were considered as of different species from others, of which they were in fact individuals of the same species; but had not yet acquired their perfect state. For want of reckoning upon this circumstance, the celebrated Linnæus has unnecessarily multiplied the number of species of these shells.

The highly ornamented surface of these shells is formed at two different periods, and by two different processes. The first appears to be that deposition which takes place from the surface of the body of the animal; and in which but little takes place different from what occurs in shells in general. But as the age of the animal advances, this surface is covered by another; the primitive colours disappear, others are disposed over them, and the substance itself of the shell becomes considerably thickened. This process is performed by a simple, but most curious organization. Two soft, membraneous flaps, or winged processes, pass out of the opening of the shell, turn back on the external convex surface, and cover it so completely as not to leave the least portion to be seen at the line where they meet each other, on the back of the shell. From the superior surface of these membraneous bodies, that surface, which clings to the convex part of the shell. exudes that secretion by which the shell is increased in bulk; and a new arrangement of the beautiful colours of its drapery is effected.

Bruguiere ascertained this formation of a second surface by actual observation at Madagascar; and the fact derives additional proof from the pale line which passes frequently along the back of these shells, marking the part where the edges of the membraneous wings met. Still more positive proof is rendered by rubbing down the second coat, when the markings of the first coat will make their appearance.

Although the colours are thus disposed by the animal, the action of light appears to have a considerable effect in augmenting their brilliancy; climate also occasions considerable differences in this respect; hence the shells obtained from the torrid zones are much more rich in their colouring than those which are found in the more temperate zones. But notwithstanding the circumstance just noticed, there is great reason for attributing the high degree of colouring in shells more to the effects of light than to the heat of the climate.

It is not the colouring only of the second coat of the porcellaneous shells which is given by this second operation, the several asperities observable in various shells, as in the Cypræa tuberculosa, and in the Cypræa pediculus, are superadded at the same period.

The form of the shell will necessarily depend on that with which the worm is first invested; but it is a curious subject of investigation, on what peculiar modification of the animal depends the spiral form of univalve shells. This has been attempted to be explained, by Reaumur, by a very simple peculiarity of organization: it being sufficient, he supposes, to consider the fibres on one surface of the body to be shorter than those on the opposite surface. From this inherent peculiarity of formation, the prolongation of the animal must necessarily be in a spiral form: and, from the various obliquities of disposition of these shorter and longer fibres, will proceed that variety of direction in which the spiral turns will be disposed.

The umbilicus, the cavity in the centre of the spire, which is seen in the lower part of the shell, depends on the direction in which the animal has extended the shell. Thus, if the turns of the spire have been carried round an axis of a conical form, each turn having departed more and more from the centre of the shell, an umbilicus will be formed, more or less open, as the turns depart more or less from the centre. But if the turns are made round an axis so straight and fine as to occasion the turns to touch each other, then no umbilical cavity will be formed at the bottom of the shell.

To enable us to account for the longitudinal, raised, and thickened ribs which cross in a longitudinal direction, the turns of the spire, and which are termed varices by Linnæus, it is necessary to refer to the formation of the opening of land shells, when they have obtained their full growth. At this period the lip of the shell, from the frequent egress and return of the animal through the opening, has an additional portion of the testaceous matter repeatedly deposited upon it, by which it acquires a bordered edge, which differs in size and thickness in the shells of different animals. But in sea shells, the growth of the shell is not completed on the formation of this bordered lip; the continuation of the spire still preceding after its formation. To explain the formation of these ribbed longitudinal projections, it is therefore only necessary to suppose the animal, after having formed the bordered edge to the mouth of the shell, to have proceeded uninterruptedly for a certain period in the formation of the common smooth surface of the shell, which, as it would then extend beyond the lately formed lip, would now render it a rib projecting from the general surface; and by a repetition of this process, a succession of these ribs, with intermediate spaces of the common surface, such as frequently exists in turbinated shells, would consequently be formed.

From a process exceedingly similar we may suppose the formation of the warted protuberances and tubercles to have proceeded; corresponding fleshy projections, existing on that part of the surface of the animal to which this part of the shell has been applied, having been the moulds, as it were, on which these have been formed. Whilst these fleshy protuberances have continued, these processes have remained hollow; but where the fleshy protuberances have been diminished, these processes have become partly filled up; and where they have been removed, these have become entirely solid, from the deposition of additional shelly matter from the surface of the animal, the existence of the cavities being necessary no longer than the continuance of the fleshy processes themselves.

The production of the spinous processes so frequent on many shells approaches still nearer to that of the ribbed protuberances, since they have been formed by little, long, tongue-like processes, with which the neck of the animal is beset, and which have served in the same manner to produce these spines as the neck of the animal has served to form the bordered edge of the shell, by an addition of the testaceous matter at each time the neck of the animal, at certain periods, passed out or returned into the shell. The confirmation of this being the mode of their formation is yielded by the circumstance of these spines being ranged in lines, at equal distances, on the ribbed protuberances, or varices of Linnæus, the formation of which has not only been similar, but simultaneous.

The production of the channel, or gutter, the cauda of Linnæus) depends on circumstances extremely similar to those on which has depended the formation of the various parts already noticed. All those animals whose shells have this termination are endued with an organ of a cylindrical form, capable of being contracted and extended, so as to allow the animal to explore its path, or to attach itself to neighbouring bodies. By the frequent employment of this organ, and by its necessarily accompanying, frequent, alternate contractions and extensions, its surface, which possesses the property of exuding a testaceous substance, must at each passage and return contribute to the formation of this canal, which would serve the purpose of a sheath to it.

By an ingenious application of these principles of Reaumur, Bruguière and Brogniart ("Bulletin de la Societe Philomatheque," No. 25) have very satisfactorily explained the production of the several fissures, striæ, grooves, and other modifications of the forms and surfaces of different shells, The author last mentioned has shown, that, in some instances, the organ by which some changes have been produced in the later formed part of the shell was not acquired by the animal until it had obtained its full size. By an application of these principles to bivalves, and even to multivalves, their peculiarities of form have also been very ingeniously accounted for. It has been found, that, in bivalves, the part of the animal which is termed the mantle is the organ on which the peculiarity of the form of each chiefly depends; it answering in this respect to the collar, or neck of the animal, belonging to univalve shells.

It does not seem necessary here to dwell on the labours of those who, previous to the time of Linnæus, had endeavoured to dispose of shells under the most comprehensive and distinctive arrangement. Whatever had been done before with this view gave way to the more lucid and correct

disposition which Linnæus adopted; but this is certainly by no means the *ne plus ultra*: other divisions appear in some instances deserving of adoption, and new genera require to be admitted. It is therefore intended to give here Linnæus's arrangement of the genera, omitting the species; afterwards to give that which has been adopted by Du Bosc, agreeable to the discoveries and observations of Lamarck, Bruguière, and others; and to offer a few explanatory remarks, for the purpose of showing the propriety or impropriety of the deviations from the arrangement of Linnæus.

MULTIVALVE SHELLS.

Genus 1. Chiton. The animal covered by several shells lying on each other along the back.

2. Lepas. The shell, which is formed of several unequal and erect valves, is affixed by its base.

3. Pholas. Shell bivalve and divaricated, with smaller, accessory, differently formed pieces at the hinge.

BIVALVES, OR CONCHÆ.

4. Mya. Gaper. Shell generally gaping at one end; the hinge with, for the most part, a thick, solid spreading tooth, not inserted in the opposite valve.

5. Solen. Razor-shell. Shell oblong, gaping at both ends; hinge with a subulated reflexed tooth, often double, not inserted in the opposite valve: the lateral margin rather obsolete.

6. Tellina. The foreside of the shell sloping downwards; the hinge, in general, with three teeth; the side teeth, in one of the valves, being either flat or wanting.

7. Cardium. Shell with equal and nearly equilateral valves, longitudinally ribbed, or sulcated, the margin dentated; the hinge having, in the middle, two alternating teeth, one commonly incurved, and two lateral, remote teeth, inserted into each other.

8. Mactra. Shell with equal, but inequilateral valves; the hinge a complicated, central tooth, with an adjoining pit, and remote lateral teeth, inserted in the opposite valves.

9. Donax. The anterior margin of the shell very obtuse, the margin often crenulated; two teeth at the hinge, and on the hinder margin, a single one (rarely two, or three, or none) somewhat remote.

10. Venus. The lips lying over the anterior margin; the hinge with three teeth close together, the lateral ones diverging from the apex.

11. Spondylus. With rigid, unequal valves; the hinge being formed by two recurved teeth, with a cavity between.

12. Chama. The shell heavy; the hinge a gibbous projection, inserted in an oblique cavity; the fore parts closed without cartilages.

13. Arca. Equivalved; the hinge with numerous, acute, and alternately inserted teeth.

14. Ostrea. With unequal valves, sometimes eared; the hinge an ovate cavity, without teeth; but, in general, with lateral, transverse striæ; no space or depression at the ligament.

15. Anomia. The valves unequal, one flattish, the other gibbous, and one of them often perforated at the base; the hinge a linear projection, with a lateral tooth, which, in the flat valve, is inserted in the margin; two bony rays support the animal.

16. Mytilus. Shell coarse, generally affixed by its byssus; hinge generally without teeth, being distinguished by a linear, subulated, longitudinal furrow.

17. Pinna. A sub-bivalve, brittle, erect, and gaping, having a silky beard. The hinge without teeth; the valves adhere on one side.

UNIVALVE SHELLS, OR COCHLEÆ.

18. Argonauta. Shell spiral, involute, membranaceous, and with one chamber.

19. Nautilus. Divided into many chambers, by partitions, perforated with projecting pipes.

20. Conus. Convoluted and turbinated shell; the aperture longitudinal, linear, open at both ends, and without teeth; the base entire, and the columella smooth.

21. Cypræa. Involuted, sub-ovate, obtuse, and smooth; the opening longitudinal, linear, dentated on each side, and extended to both ends of the shell.

22. Bulla. Convoluted, without spire, opening longitudinal, oblong, and contracted at the ends, entire at the base; the columella oblique and smooth.

23. Voluta. Unilocular and spiral; the aperture without a tail, and somewhat open at both ends; columella plaited, with no inner or columellar lip, nor umbilicus.

24. Buccinum. Spiral and gibbous; the aperture oval, terminating in a gutter, which, with the cauda, runs out to the right; the interior lip smooth.

25. Strombus. Spiral, with one side large, the aperture frequently with a dilat-

ed outer lip, terminating in a gutter which turns to the left.

26. Murex. Spiral and rough, with membranaceous sutures; the aperture ending in an entire, straight, or somewhat ascending gutter.

27. Trochus. Spiral, and nearly conical; the aperture nearly tetragonal or rounded, contracted transversely above; the columella oblique.

28. Turbo. Spiral and solid; the aperture contracted, orbicular, and intire.

29. Helix. Spiral, subdiaphanous and fragile; aperture close at the ends; within lunated, or partly circular, as if a segment of the circle had been cut off.

30. Nerita. Spiral, gibbous, and flattish below; the aperture semiorbicular, or semilunar; the lip of the columella transverse and flattishly truncated.

31. Haliotis. Ear-shaped; the mouth spread open; the spire lateral and flattened; the disc almost always perforated with a row of holes.

32. Patella. Nearly conical and without a spire.

33. Dentalium. Tubular straight, with one chamber, open at both ends.

34. Serpula. Tubular, adhering to other bodies, often intercepted by intire partitions.

35. Teredo. Round, bending, and lodged wood.

36. Sabella. Tubular, formed by grains of sand, on a membranous sheath.

The French naturalists, whose late exertions have added much to the funds of this science, have thought it necessary to adopt some changes with respect to the preceding arrangement. These changes would, indeed, derive some support from the high characters which have suggested them; no one having done more of late years to the advancement of this species of knowledge than Bruguière and Lamarck. Their observations shall therefore be introduced under the several genera to which they apply, whilst the order in which they are taken shall be that of Bosc, in "Histoire Naturelle des Coquilles."

MULTIVALVE SHELLS.

Lamarck thinks that Pholades should be regarded as bivalves, having accessary pieces, and that the Oscabrions (Chitons) should be considered as naked molluscæ, whose backs are beset with small testaceous laminæ. Bosc, however, in conformity with accustomed practice, considers them among the multivalve shells.

Dacosta (Conchology, 8vo. p. 97.) observes that "The Greek name lepas, always synonimous with the Latin name patella, the latter signifying little sacrifice dishes, or saucers, was given to limpets from the earliest Grecian times, and the Roman name from their resemblance to those little dishes; yet Linnæus wantonly transposes the name of Lepas to the Balani." The French naturalists have still continued the name of Lepas to the Patellæ, and have separated those bodies which Linnæus had placed under the genus Lepas, into two genera: 1. Anatifa, a cuneiform shell composed of several flat unequal valves, connected together by a membrane, and united to the extremity of a tendinous tube fixed by its base; and, 2. Balanus, a conical multivalve shell, fixed by its base, and composed of six articulated valves, the openings closed by an operculum, with four valves. These shells had been united by Linnæus under one genus, most probably in consequence of the similarity of the animals by which they are inhabited; but the French naturalists observe, in confirmation of the propriety of the distinction which they have adopted, that very essential differences exist between the animals of the Anatifæ and of the Balani.

The Teredo is considered by Bosc as a multivalve shell, formed of five unequal pieces; the largest is a cylindrical tube, in which the others are contained. Two extremely thin and nearly hemispherical pieces, resembling parts of a Pholas, pointed at one of their ends, and beset on their outer surface with twenty-five rows of small teeth, like those of a file, are placed at their lower extremity, and by their action remove the wood, and form the cavity in which the shell becomes lodged. At the superior extremity, that which communicates with the water, are two small roundish pieces, connected with the animal by cylindrical pedicles about their own length. When the animal stretches a little out of the tube, these valve-like pieces spread out, and when it re-enters, they contract and close the opening, through which the head, or rather the syphons of the animal had passed.

Bruguière has, apparently with much propriety, introduced a new genus which he has termed Fistulana, the characters of which are a tubular club-formed shell, open at its smaller extremity, and containing in its cavity two valves. The shell, the exa-

mination of which led to this separation, is the Hercules club, considered by Gmelin as a Teredo, and named by him Teredo clava. The shells of this genus seem to differ from the Teredines only in containing one, whilst the Teredo contains two pair of valves. The Pholas hians and Pholas teredula of Gmelin appear to be merely the interior valves of two species of Fistulanæ.

From the several species which Linnæus has collected under his genus Anomia, Lamarck and Bruguiere have formed six distinct genera, which they have named Anomia, Calceola, Terebratula, Crania, Placuna, and Hyalæa, which they describe as being thus characterised:

Anomia, an irregular shell, formed of two unequal valves, the inferior of which is either pierced or grooved at its beak, the opening being closed by a small operculum, or third valve, which fixes on other bodies, and is attached by a ligament. The hinge is without teeth. It is by possessing this third body, therefore, whether considered as valve or operculum, that this genus is distinguished.

BIVALVE SHELLS.

Calceola. A regular bivalve shell, with unequal valves, the largest being in the form of a half sandal, and the smallest flat, semiorbicular, and resembling an operculum; the hinge with from one to three small teeth. This shell is only known as a fossil, and is considered by Gmelin as an Anomia (Anomia sandalium). It is very thick, and about an inch in length. Its back is flattened; its interior is striated longitudinally, and its valve or operculum, concentrically.

Terebratula, a regular bivalve shell, with unequal valves, fixing itself by a ligament or short tube; the largest valve perforated at its summit, which is prominent and recurved; hinge with two teeth. The regularity of the valves, the absence of any operculum, the position of the hole, and the form of the hinge, separate this genus from that of Anomia.

Crania, a regular bivalve shell, with unequal valves, the inferior almost smooth, and nearly round, and pierced in its internal face with three unequal and oblique holes; the superior valve very convex, furnished internally with two projecting callosities. The three holes in the inferior valve of this shell, induced Lamarck and Bruguiere to separate it from the Anomiæ, and place it in a distinct genus. The species described by Linnæus is named by him Anomia craniolaris.

Placuna, an irregular bivalve flat shell; the interior hinge composed of two diverging ridges, which serve for the attachment of a ligament. Linnæus has arranged two species, Anomia placenta, and Anomia sella, under the genus Anomia.

Hyalæa, a regular bivalve shell, with unequal, bulging, connées, transparent valves, gaping under the beak, and tricuspidated at the base. This genus is formed by Lamarck, from a shell described by Forskal, and denominated in Gmelin's Linnæus Anomia tridentata, caudata and retusa. The Clio pyramidata of Linnæus are also referable to this genus.

Lingula, a long flat shell, formed of two valves, nearly equal, truncated in the forepart; the hinge without teeth; the beak of the valves pointed, and joined to a tendinous tube, which as a ligament to the shell, and fixes it to other solid bodies. Linnæus, who knew only of one valve of this shell, termed it Patilla unguis.

Corbula is an unequal-valved, sub-transverse, smooth, regular shell; with a conical cardinal tooth, curved, or turned upwards, on each valve; interior ligament, and two muscular impressions. This genus is characterised by the inequality of its valves, one of them being nearly a third larger than the other. These shells are found fossil at Grignon, near to Versailles.

Orbicula is a genus formed by Lamarck from a shell which was discovered by Muller, and which was named by him Patella anomala. Its differing so entirely from Patellæ in being a bivalve, and its being inhabited by an animal totally different from that of the Patella, has induced Lamarck thus to separate it from the genus Patella. This shell is orbicular, but rather flattened, and composed of two valves; by the lowest of which, which is extremely delicate, it adheres to other bodies. Its hinge is not known.

Pandora is a regular inequivalved, and inequilateral shell; with two cardinal, oblong, unequal, and diverging teeth, in the upper valve; and two oblong pits in the other valve; and interior ligament, and two muscular impressions. The shell [illegible] rise to this genus is Tellina [illegible] Linnæus; the inequality [illegible] ing the circumstance [illegible] warrant the separati[illegible] Pandora margi[illegible]

Lima. An inequilateral-eared bivalve; the valves a little gaping on one side; hinge without teeth; ligament external; beaks separated. This genus is founded chiefly on the Ostrea lima of Linnæus, now named by Bruguiere, Lima squamos. The separation of these shells from the Pectens, on the idea of their forming a byssus, whilst the Pectens do not, requires, it should seem, a more accurate knowledge of the habits of the animals which occupy the different Pectens.

Pecten. This, contrary to Linnæus, is adopted by Bruguiere as a genus distinct from Ostrea. Its characters are given: a regular bivalve shell; the valves unequal; the hinge without teeth, most commonly eared, with a triangular pit for the ligament. The hinge shutting by a black ligament fixed in this triangular pit, and the different forms of the shells are the circumstances which are supposed to warrant the proposed separation.

Pedum. The shell from which this genus has been formed, and of which only one species is known, being that which is figured by Chemnitz and Favanne, is semi-transparent, unequal-valved, eared; the inferior valve gaping; the beaks separated; hinge without teeth; ligament external, and attached to a long and narrow gutter. The upper valve is striated, and granulated longitudinally; but the under valve is smooth, sharply edged, and hollowed out in one part.

Perna. An irregular, flattish, bivalve, shell: the hinge composed of many linear, parallel teeth, disposed in a straight line, across. The hinge is closed by a ligament which is attached between the teeth, and which, by its thickness, prevents the teeth from articulating with each other. Ostrea perna, isogona, ephippium, pictum, and legumen, of Linnæus, are placed under this genus.

Avicula. This genus Lamarck forms from Mytilus hirundo, Linnæus, which is the only shell in the genus. He describes it: an irregular, loose shell, a little gaping towards its beaks, and having the valves of unequal size. The hinge callous, without teeth; a little oblong pit, which is marginal and parallel with the edge which supports the ligament.

Malleus. The hammer-oyster of Linnæus, with two other species, form this genus, according to Lamarck, who gives for the characters of the genus: an irregular loose shell, a little gaping near its beaks, having equal valves; a callous hinge, without teeth, having a conical pit, placed obliquely on the edge of each valve. This genus seems to be hardly sufficiently distinguishable from the last; nor does the name of the genus appear to be well adapted, since some of the species no ways resemble a hammer in their form.

Vulsella. This genus is formed from the Mya vulsella of Linnæus. The uncertainty with which this shell has been viewed, at different periods, shows the uncertainty of its nature, and the propriety of not placing it under any other genus. Linnæus had once considered it as a Pinna, and Bruguiere as an oyster. It is a loose shell, longitudinal, and nearly equivalved, terminating in a very short bent beak; the hinge callous, depressed, and without teeth, of equal elevation on each valve, forming a rounded conical pit for the ligament.

Ostrea. In this genus is comprehended those shells only which are oysters, according to common acceptation. The characters of the genus are, therefore, an irregular, adherent, inequivalve shell; the hinge without teeth; an oblong pit, sulcated across, giving attachment to a ligament.

Gryphæa. The shell, for the reception of which this genus was established by Lamarck, was improperly considered as a species of Anomia by Linnæus, and as a species of oyster by Bruguiere; to which latter genus it undoubtedly very nearly approximates. It is a loose unequivalved shell; the inferior valve concave, terminated by a beak turned upwards, and bent into an involved spire; the superior valve smaller, like an operculum; the hinge without teeth, but with an oblong and dented pit; and one muscular impression in each valve. Lamarck enumerates eight fossil species of this genus.

Plicatula is a genus formed, by Lamarck, from Spondylus plicatus of Linnæus. It is an angulated shell, with unequal valves and unequal beaks, which are pointed; the edges are in deep plaits; its hinge is formed of two strong teeth on each valve, and an intermediate pit for the reception of the ligament; with one muscular impression on each valve.

Spondylus. In this genus of Linnæus are comprised bivalve, irregularly-formed shells, the hinge of which is formed of two strong hooked teeth, and an intermediate pit for the ligament; in the inferior valve are two

thick recurved teeth, with two intermediate rounded cavities to receive the teeth of the other valve, and an elongated pit in which the ligament is placed; in the superior valve are two exterior cavities for receiving the teeth of the other valve, and two teeth curving backwards, with a pit for the ligament.

Chama. This genus is appointed, by Bruguiere and Lamarck, to those shells only which, in particular, possess unequal valves, and are adherent. The characters of the genus therefore are: a bivalve shell, with adhering unequal valves; the hinge composed of one oblique thick tooth, which may be crenulated or rough, and is articulated in a cavity in the opposite valve.

It was necessary, therefore, to establish other genera for the reception of those shells which thus become excluded from the genus Chama. Hence Bruguiere formed too new genera; Cardita, having two teeth in the hinge; and Tridacna, possessing the same number, but having the edges of the crescent crenulated and gaping. Lamarck has proceeded still further; he has subdivided the genus Cardita from an isolated tooth, situated, in some species, under the corslet, as in Cardium isocardia, and makes this his genus Isocardia. He also makes another genus, Hippopus, the species of which are subtransverse, inequilateral shells; the hinge with two compressed, inverted teeth, the crescent filled up: of this genus is Chama gigax. But it is necessary still further to particularise these new genera.

Cardita, a loose inequilateral shell, the hinge with two teeth; the one at the base of the left valve, and the other longitudinal, parallel with the anterior face.

Hippopus. An inequilateral, subtransverse shell; the hinge with two compressed and inverted teeth; the crescent filled up. Hippopus, it is to be remembered, differs from Tridacna by having its crenate filled, whilst in Tridacna it is gaping.

Tridacna. An inequilateral, subtransverse shell; hinge with two teeth, compressed and inverted; the crescent gaping. The Chama gigas of Linnæus (the Tridacna gigas of Lamarck) is the only species under this genus.

Cardium. This genus remains unaltered by the French naturalists. The characters being: a sub-cordiform shell, with valves dentated on their edges; the hinge with four teeth; two cardinal, approximating obliquely in each valve, and articulating across with their correspondent teeth; the lateral teeth distant, and inverted in the opposite valve.

Acardo. Is a genus very properly established by Commercon. It is founded on two species: the generic characters of which are: a shell composed of two, nearly equal, flat valves; having neither hinge nor ligament; a muscular impression appearing on the centre of each valve.

Radiolites. This is a genus approximating to the preceding, but very properly separated from it by the form of the shell. The shell is of an irregular form, of unequal valves, striated on the outside; the inferior valve turbinated; the superior convex, or conical; no hinge nor ligament.

Erodona. This genus was formed, by Daudin, from two shells in the cabinet of Favannes. It is intermediate between the Mya and Mactra. It is a subtransverse, bivalve shell, irregular and gaping; one of the valves having a hollow tooth; and the other a pit between two projections; the ligament inserted on the tooth and in the pit.

Mya, is a transverse shell, gaping at both ends; the ligament on the inside; the left valve having a cardinal tooth, compressed, rounded, perpendicular to the valve, and giving attachment to the ligament. This is the original genus of Linnæus, from which Bruguiere and Lamarck have withdrawn many of the species to place them under the genera Vulsella, Glycemeris, and Unio; leaving only those sea-shells which have a very projecting cardinal tooth in one of their valves.

Glycemeris. A transverse shell, gaping at both extremities: a protuberant hinge without teeth; the ligament on the outer part. Such is Mya glycemeris of Linnæus.

Solen. A transverse shell, gaping at both extremities: the upper edge straight, or nearly so; two or three teeth at the hinge, furnished by both valves.

Tellina. Considerable confusion has arisen from the admission of species which by no means belong to this genus. Bruguiere and Lamarck have divided the Tellens of Linnæus into two new genera. 1. Tellina, a transverse or orbicular shell with equal valves, with a fold on the anterior side: one or two cardinal teeth, and two separated lateral teeth, as in Tellina virgata. 2. Caspa, a transverse shell, with

two teeth in one valve, and one tooth in the opposite valve, shutting between those of the other valve, as in Tellina angulata.

Cyclas. This genus comprehends some shells which Linnæus had associated with Tellens; but which Bruguiere and Lamarck have separated from them, from their wanting the fold on the anterior side. The characters are: A suborbicular, or in a small degree, transverse shell, without fold on the anterior side; the ligament external and bulging; two or three cardinal teeth, and elongated, lamelliform, inserted lateral teeth. They are fresh water shells.

Venus. This genus of Linnæus is formed by shells which are regular, suborbicular, bivalves, provided with a crescent and a corslet; three cardinal teeth near together, and sometimes one or two lateral teeth. The valves of this genus are generally pretty gibbous and thick; constantly equal, and nearly of a triangular form. Lamarck divides this genus into two. 1. Venus, a suborbicular or transverse shell, with three approximated cardinal teeth, the lateral ones being more or less diverging. 2. Meretrix, a transverse or orbicular shell; with three approximated cardinal teeth, and one isolated tooth under the crescent. The genus Caspa, mentioned above, is proposed by Bruguiere and Lamarck to comprise several of the Venus's of Linnæus.

Ungulina. A regularly formed long bivalve; the hinge formed by a very small tooth between two oblique dents: the valves bearing the form of the finger nail. There is but one species in this genus. The hinge bears some resemblance to that of Cardium, but the general form of the shell differs much from that of Cardia.

Donax. A regular, transverse, inequilateral bivalve, with three cardinal teeth, and one or two separated lateral teeth. Shells of this genus have much of the triangular form, their sides very unequal; they are solid, thick, flattened at the inferior, and rounded at the opposite, extremity. The ligament, which, in most shells with equal valves, is placed above the summit, is in these shells unequally distributed above and below it. Above; it is narrow and short; and below, it is thick, nearly round, and fills the cavity of the corslet exactly.

Mactra. A bivalve shell, regular, transverse, inequilateral, and a little gaping, the cardinal tooth having a pit for the ligament; lateral teeth compressed and inserted, or none.

Lamarck divides this genus into three. 1. Mactra, a transverse, inequilateral shell a little gaping; the cardinal tooth folded in a furrow, articulating with that of the opposite valve, and accompanying a pit for the ligament; two lateral and inserted teeth, such is Mactra stultorum. 2. Lutraria, a transverse, inequilateral shell, gaping at the extremities; two cardinal teeth, oblique, and diverging, accompanying a large pit for the ligament; no lateral teeth; such is Mactra lutraria, Linnæus. 3. Paphia, a subtransverse, inequilateral shell, the valves close: a pit for the ligament on the beak between or near to the teeth of the hinge, as in Venus divaricata. Linnæus.

Crassatella. A genus formed by Lamarck of shells unknown to Linnæus, and which Bruguiere had placed in the genus Mactra. The generic charararacters are an inequilateral, subtranverse shell, with close valves, with a sunk crescent or corslet; the ligament internal; the pit for the ligament placed under the beaks, above the teeth of the hinge. There are two fossil, and one recent species under this genus. These shells are remarkable for the thickness of the valves, and for their two deep muscular impressions.

Trigonia. This is a genus formed by Lamarck, the species of which are known only in a fossil state. The characters of the genus are, an inequilateral subtrigonal shell, the hinge formed by two large flat diverging teeth, transversely grooved. These are the Cunei of Dacosta.

Hiatella. A genus formed by Daudin on two shells from Tranquebar, which appear to be intermediate between the genera Trigonia and Tridacna; the characters are a transverse, irregular bivalve shell, gaping in its superior edge; its hinge a tooth in each valve, inserted in a groove in the opposite valve.

Cucullæa. A gibbous, subtranverse inequilateral shell, with detached beaks: the hinge in a straight line, having a range of numerous teeth, transverse inserted; and at the extremities two or three parallel rib-like teeth, the ligaments external. This genus is founded by Lamarck on a recent shell from the Indian Sea, and on a fossil shell from Beauvais, which Bruguiere had placed among the Arks; from which these shells differ in the ribs placed at the extremities of the hinge.

Arca. An inequilateral bivalve shell; the hinge composed of numerous teeth, which lock in the interstices of those of the opposite valve, and which range in a straight, angular, or curved line. The ligament

external. This genus of Linnæus has been subdivided by Lamarck into three genera. 1. Arca, with the teeth of the hinge in a straight line, as the Arca noæ. 2. Pectunculus, with the hinge in a curved line; and 3. Nucula, which deserves a distinct notice.

Nucula. This genus has been formed by Lamarck from Arca nucleus, Linn. Daudin has also added two more species. The shells of this genus evidently differ from the Arks, in having their insides resplendent with the mother of pearl, and in having a large tooth at the hinge. The characters are, an inequilateral, almost triangular or oblong shell; the hinge in a broken line, beset with numerous transverse and parallel teeth; one oblique cardinal tooth out of the line; the beaks contiguous and turned forwards.

Unio. A transverse shell with three muscular impressions; an irregular, callous, cardinal tooth, stretching on one side, under the corselet, and articulating with one of the opposite valve. In this genus, formed by Bruguiere, are placed the Mya margaritifera and Pictorum of Linnæus.

Anodonta. A regular transverse bivalve shell, having three muscular impressions: a simple hinge without any tooth. In this genus are placed Mytilus cygneus, anatinus, and fluviatilis of Linnæus, with three other species.

Mytilus. A regular transverse shell with equal valves, shutting close, a hinge without, or with one or two teeth. Lamarck divides the genus Mytilus into four genera. 1. Mytilus, a longitudinal shell, with pointed terminating beaks; one muscular impression, and a hinge most frequently without teeth. 2. Modiolus, a subtransverse shell, the posterior extremity very short; the beaks sunk upon the short side of the shell; one muscular impression; the hinge simple, without teeth. 3. Avicula. 4. Anodonta.

Pinna. The characters of this genus are, a regular bivalve shell, with equal valves, wedge-formed, pointed at its base, gaping at its superior edge; hinge without teeth, and lateral ligament very long.

UNIVALVE SHELLS.

Patella. A conical univalve shell, without a spire. Linnæus had divided these shells into five sections; the labiated, the dentated, the mucronated, the entire, and the perforated. Lamarck has divided this genus into five: 1. Patella, a shell of a shield or bonnet form, without a spire, whole at the top, and simple within. 2. Crepidula, an oval shell, with an incomplete spire, inclined on the edge; the cavity separated into two, by a simple diaphragm. 3. Calyptra, a conical shell, whole at the point; with a spiral diaphragm. 4. Fissurella, the shell pierced with a hole at the point. 5. Emarginula, a conical shell, summit inclined, concave beneath, and the posterior edge slit or grooved.

Planospirites. A suborbicular flattish univalve, having in its inferior face, on one side, a cord-like border, turning back in spiral turns on the disc of the shell. The genus is formed by Lamarck on a fossil shell found by Faujas among the fossils of Maestricht; but the figure has not yet been given.

Testacella. A univalve shell, in form of an oblique cone, the summit being rather spiral and the opening oval. This is the covering of the posterior part of a long gasteropodia from the isle of Teneriffe. This is therefore an animal between the slug and the snail.

Oscana. An oval, coriaceous, almost transparent univalve shell without a spire. The shell of this genus, and of which one species only is known, which is found adhering to prawns, is in form similar to the Patellæ, and the animal approaches to that of the Chiton.

Carinaria. A univalve shell, very thin; its form a cone, flattened on its sides; its summit rolled, spirally and very small; the back covered with a dentated keel; the opening entire, oval, oblong, and contracted towards the angle of the keel. Linnæus had placed this shell, which is exceedingly delicate, and as transparent as glass, among the Patellæ, by the name of Patella cristata, but Dargenville, Martini, and Gmelin, have ranged it under the Argonauta by the name of Argonauta vitrea. Bruguière appears to have been disposed rather to have replaced it among the Patellæ; but Lamarck has thought it right to consider it as a species of a distinct genus.

Haliotis. A flattish, ear-formed shell; the spire much sunk; the opening very large; much longer than wide; pierced with holes disposed in a line. No change is proposed in this genus of Linnæus by the French testaceologists.

Sigaretus. An oval, depressed, nearly ear-formed shell, with a short spiral columella; the opening entire, very large, widened near the top of the right lip, and

longer than wide. This shell had been placed by Linnæus among the Helices, under the name of Helix haliotoidea; and by Muller among the Bullæ, under the name of Bulla velutina; but Lamarck seems very properly to have disposed of it under a distinct intermediate genus between the Nerites and the ear-shells.

Stomatia. Is a genus which has been formed by Helblins and Lamarck from a shell, which had been placed under the genus Haliotis, but which wanted the holes, which exist in the shells of that genus.

Argonauta. A very thin, single chambered univalve shell; the spire concealed in the internal part of the shell.

Concholepas. An oval univalve, convex in its superior part, with its summit obliquely inclined upon the left edge; the cavity simple; two teeth and a sinus at the base of the right edge. Dargenville and others had placed the shell of this genus among the Patellæ; but Bruguiere having seen several with tendinous opercula, disposed them under the genus Buccinum. Lamarck has however thought fit to consider it as forming a genus, connecting the Patellæ with the other spire valved shells.

Nerita. A semiglobular univalve, flattish beneath, not umbilicated at the spire; the opening semicircular the columella or partition, nearly transverse. Lamarck has retained in this genus only the imperforated Nerites; the others he transfers to the next genus. The Nerites have not only no umbilicus but no true columella, having in its place, a simple partition; which is flat, thin, and longitudinal, originating in the groove of the first spire, and generally dentated.

Natica. This genus of Lamarck's is characterized by a nearly globular shell, umbilicated at the left lip with a callosity at the umbilicus; the opening semicircular; the columella oblique, and not dentated.

Helicina. This genus is founded by Lamarck on a shell figured by Lister (Plate LXXI. fig. 59) and which he describes as a globular shell; the opening entire, semioval; columella with a callus, compressed inferiorly; an operculum. The propriety of this adoption cannot be judged of, from merely the figure of this shell in Lister's work.

Helix. An orbicular or elongated univalve, with an obtuse or concave spire; the opening entire, forming a half moon. Lamarck divides the shells which have been hitherto disposed under this genus into eight genera. 1. Bulimus, an oval or oblong shell, the opening whole, longer than wide; the columella smooth, without folds, truncature or widening at the base; as in Bulima hæmastoma. 2. Lymnæa, an oblong subturriculated shell, longer than wide; opening entire, the inferior part of the right edge, turning up and passing into the opening, and forming a very oblique fold on the columella; as in Helix stagnalis. 3. Melania, a turriculated shell; the opening entire, oval or oblong, widened at the base of the columella; Helix amarula is of this genus. 4. Ampullaria, a globular bellied shell, umbilicated at its base, no callosities on the left lip; the opening entire, longer than wide. Helix ampullacea forms this genus. 5. Planorbis. A discoid shell, the spire flattened or sunk, not prominent, the opening entire, longer than wide, and filled up laterally by the convex projection of the last turn but one. The type of this genus is Helix planorbis. 6. Haliotidea. 7. Ianthina. 8. Helix, a globular shell, with a convex or conoidal spire; and particularly with the opening diminished by the projection of the last turn but one; but as this last character is common to the Planorbis also, these two genera are evidently confounded. The separation which is hereafter made of some shells which originally were in the genus Helix, in agreement with the ideas of Bruguiere, will be, therefore, more correct.

Volvaria, a cylindrical shell, twisted on itself, without a projecting spire; the opening narrow, as long as the shell; one or more folds on the base of the columella. This genus was formed by Lamarck from a shell which is figured and described by Pennant, vol. iv. Plate LXX. fig. 85. He considers it as intermediate between Bulla and Bulima.

Bulla. A tumid shell, the spire not projecting; the opening as long as the shell; no umbilicus. This genus of Linnæus has been much reduced by Bruguiere, who placed several species under Bulima, and established his genus Ovula. Lamarck has still further reduced them, by forming the genera Terebellum, Pyrula, Ampulla, and Achatina.

Ianthina. This genus is formed by Lamarck on a single shell described by Lister, Brown, Forskal, and other naturalists; which derives its claims of distinction from Helix, not so much from the character of the shell as from that of the animal, which differs in its structure materially from the animal of the Helix, since it is furnished with a curious apparatus, being an inhabi-

tant of the sea, for swimming, instead of that for crawling, with which the Helices are provided. It is nearly globular, and almost diaphanous; the opening is nearly triangular, with an angular sinus at the right edge.

Turritella. This genus was formed by Lamarck, for the reception of those shells which Linnæus had placed in the last section of his genus Turbo, as Towers; and which Dargenville and Favanne had considered as screws. The characters of the genus are, a turriculated shell; the opening round, whole, but having a sinus at the right edge.

Cyclostoma. This genus was formed by Lamarck for the reception of the Wentletrap, and other shells of the same character. The propriety of thus forming a new genus is rendered evident by the doubts which had arisen respecting the placing of it in any old genus. Linnæus having considered it a Turbo; Rumphius, a Buccinum; Dargenville, a Screw; and Davila, Gualteri, Guettard, and Favanne, merely a Tube, from its not possessing a columella, which they considered as essential in a univalve shell. The shells of this genus differ in their forms; their openings are nearly round, and their sides connected circularly. The shell is formed of seven spires, separated by a void space; with ten or twelve longitudinal ribs, which uniting, form a rim round the lip. These ribs externally supply the place of a columella.

Bulimus. A globular, oval, or turriculated shell, the opening of which is entire, not grooved at the base, and always longer than wide. This genus of Bruguiere comprises some of the shells considered by Linnæus as Helices and Bullæ; and the genera Auricula, Pyramidella, Melania, Lymnæa, Agathina, Maillot, and Bulima, of Lamarck. The essential character distinguishing this genus from Helix is the opening being longer than it is wide.

Turbo. A conoidal or turriculated shell; the opening entire, round, without any tooth; the edges disjoined on the superior part. Several shells which were reckoned by Linnæus of this genus have been removed from it by Bruguiere, and placed under his genus Bulima, and others have been taken from it by Lamarck, and disposed under the genera Cyclostoma and Turritella.

Trochus. A conical univalve shell; the opening almost always quadrangular, flattened transversely; the columella oblique. Lamarck has divided this genus into four: 1. Trochus. 2. Solarium, with an open, umbilicus, or crenulated opening on the inside of the spiral turnings, as in the Trochus perspectivus. 3. Monodenta. The opening rounded, and furnished with a tooth formed by the truncated and projecting base of the columella, as in Trochus labio, Linnæus. 4. Pyramidella; the columella projecting, perforated at its base, and possessing three transverse folds, as in Trochus dolabratus, Linnæus.

Cerithium. A univalve turriculated shell, the opening terminated at its base by a short, narrow canal, either suddenly turning backwards or truncated, but never grooved out. In this genus of Bruguiere are comprehended several shells from the genera Trochus, Strombus, and Murex of Linnæus. The shells differ from those of Murex by their turriculated form; and from the screws, in not having the groove at the base of the canal.

Pyrula. A subpyriform shell, canaliculated at its base; without any projections, and having the belly part nearer to its summit than to its base; the spire short; the columella smooth; the right edge without a groove. Lamarck founding the distinction on the situation of the bellied part of the shell, and on the greater or less length of the spire, has formed two new genera; one with those shells possessing this character of the genus Bulla, and the other of the genus Murex, calling the former Pyrula and the latter Fusus.

Murex. An oval or elongated univalve shell, generally foliated, plaited, spinous, or tuberculated; the opening always prolonged into a canal, running straight, or turning directly backwards, and always entire. In the earlier stages of their growth it is difficult to separate the Murices from the Strombi. Lamarck divides this genus of Linnæus into five genera. 1. Murex, with tuberculated or spinous projections, and channelled at the base, as M. ramosus. 2. Fusus; fusiform, without projections, with the bellied part either equally distant from the extremities or nearest to the base; spire elongated; columella smooth; right edge without groove, as M. colus. 3. Fasciolaria; nearly fusiform; no projections; with two or three very oblique folds on the columella; and channelled at the base, as in M. tulipa. 4. Pleurotoma: fusiform or turriculated, without projections, and having a groove, or sinus, near the summit of the right edge, as in M. babylonicus. 5. Cerithium, already described.

Rostellaria. Lamarck has formed this genus on Strombus fusus, (Linnæus) and on some fossil species found at Courtagnon. The characters of the genus are: a fusiform shell, terminating inferiorly by a canal with a pointed beak; the right edge entire or dentated; dilated more or less in a wing, according to age, and having a sinus contiguous to the canal.

Strombus. A bellied univalve, terminating, at its base, by a canal, accompanied with a distinct sinus; the right lip dilating, or spreading itself out, with age, in a simple or digitated lobe. Lamarck divides the genus Strombus of Linnæus into three. 1. Strombus; terminating in a short canal, truncated or grooved out; the right edge dilating, with age, into a simple entire wing or lobe; with a sinus distinct from the groove at the base, as in S. pugilis. 2. Pterocera; a bellied shell, terminated inferiorly by an elongated canal; the right edge dilating, with age, in a digitated wing, and having a sinus near its base, as in S. lambus. 3. Rostellaria, the genus last described.

Buccinum. An oblong or oval shell, the opening of which is terminated at the base by an oblique groove, without any sensible canal, or external border. Bruguiere has divided the Buccina of Linnæus into the genera Buccinum, Terebra, Cassidæa, and Purpura. Under the genus Buccinum are therefore here comprised tumid shells, with from three to ten spiral turns; a summit generally flattish; a surface rarely even; the predominating colours dull; the lip extended more or less in a bow, and rarely jagged.

Cassidæa. A tumid shell, the opening longer than wide, terminated at its base by a short canal, recurved towards the back of the shell; the columella plaited in the lower part. This genus of Bruguiere is intended to comprise the helmets (casques) of Gualteri, Klein, and others.

Terebra. A turriculated univalve; the opening grooved in the lower part; the base of the columella twisted or oblique.

Purpura. An oval shell, generally with spines, or tuberculated; the opening terminating in a very short canal, the extremity of the canal grooved out, the base of the columella finishing in a point. The shells included in this genus by Bruguiere, are not those species which have been hitherto considered, as Purpuræ, by Dargenville and others, and which belong to the genus Murex; but those species which appear to connect the genus Buccinum and Murex. The opening of these shells is rather large, oval, round, upwards, and more contracted in the inferior part; the right lip has but little thickness, and is grooved or notched; the left expands with a wrinkled ridge, which terminates in the groove.

Voluta. A cylindrical, or oval, univalve shell, grooved out at the base, but without a gutter; the opening longer than wide; and the columella plaited. The division of this genus by Linnæus is very clear and useful; but Lamarck proposes a still nicer distinction of the shells of this genus, by dividing them into eight genera. 1. Voluta, an oval shell, more or less bellied, summit obtuse or mammillated; the base grooved, but without a gutter; the columella with several plaits, of which the lowest are largest and longest; as in Voluta musica. 2. Oliva, sub-cylindrical, grooved at the base; the turns of the spire separated by a channel; the columella striated obliquely, as in Voluta oliva. 3. Ancilla, oblong, a short spire, base of the opening hardly grooved; a swelling, or oblique roll, at the base of the columella. 4. Mitra, fusiform or turriculated, spire pointed at the summit, the base grooved out, without a gutter; the columella with plaits, the lowest being the least, as in Voluta episcopalis. 5. Columbella, marked by a swelling on the internal face of the right edge; as in Voluta mercatoria. 6. Marginella, the right edge emarginated, as in Voluta vespertilio. 7. Cancellaria, the right edge grooved internally, and the base of the opening almost entire, as in Voluta reticulata. 8. Turbinella, sub-turbinated, canaliculated at its base, with transverse plaits on the columella.

Ovula. A tumid shell, more or less elongated at the extremities; the edges rolled inwards; the opening longitudinal, not dentated on the left side. This genus is formed by Lamarck from shells, which had been comprised by Linnæus in his genus Bulla. The shells of the genus Ovula differ from those of Cypræa, chiefly by the absence of teeth from the left-side. Bulla volva, ovum, spelta, verrucosa, and gibbosa, of Linnæus are placed under this genus.

Terebellum, a shell nearly cylindrical, pointed at the summit; the opening longitudinal, narrow upwards, and hollowed out at its base; the columella truncated. This genus is formed by Lamarck, of the Bulla terebelum of Linnæus, which he has removed from the genus Bulla, and has placed in this genus, as intermediate between the Ovulæ and the Olives.

Cypræa. A convex, univalve shell, the edges turned inwards; the opening long and narrow, and toothed on each side. The shells of this genus are so distinctly characterized as to have escaped that confusion which has taken place in many other genera.

Conus. A conical, convoluted univalve; the opening of the length of the shell, linear, without teeth, and hollowed out at the top; the columella smooth. The generic characters are here so determinate, as not to have left any opportunity for changing the acceptation of this genus, as established by Linnæus.

Vermicularia. A tubular shell, twisted in an irregular spiral, in general adhering to some body; and furnished with an operculated opening. The shells with which Lamarck has formed this genus, were blended by Linnæus with the Serpulæ; but the animals which inhabit these shells are very different from the Terebrellæ, which are the only inhabitants of the true Serpulæ.

Silicaria. A tubular shell, spirally convoluted, and laterally divided through its whole length by a narrow fissure; the mouth roundish. Linnæus himself considers it as doubtful whether the shell which forms this genus (Serpula anguina) should be placed under the genus Serpula, or not; but Bruguiere, Lamarck, and Daudin, have thought it necessary to establish for it this new genus.

Penicellus. A long tubular conical shell, the superior extremity closed by a disc, beset with numerous short tubes, and surrounded by a projecting coronet; the inferior extremity having been fixed to some solid body. Linnæus had doubted whether the shell, of which Bruguiere has formed this genus, ought not to be placed under the genus Teredo, rather than under that of Serpula, where, however, he left it.

Nautilus. A spiral and nearly discoidal shell, the last turn of which envelopes the rest, and the sides of which are smooth: numerous chambers formed by transverse smooth septa, perforated by a tube. This genus is divided by Lamarck into three. 1. Nautilus, 2. Spirula, 3. Orthocera.

Orbulites. A spiral, and nearly discoidal shell, the last spire enveloping the rest; the sides articulated by winding sutures; the transverse septæ being pierced by a marginal tube. The shells which Lamarck has assumed for this genus have been hitherto confounded with the Ammonites: they are only known as fossils and as casts.

Ammonites. A discoidal spiral shell, the turns contiguous and all visible, the sides articulated by foliated sutures, and the transverse septæ terminating in winding processes, and pierced by a marginal tube. These, like the shells of the preceding genus are only with certainty known to exist as fossils.

Planulites. A discoidal spiral shell, with contiguous and visible turns, with smooth sides, and transverse septæ, not foliated. These shells are supposed to bear the same relationship to the Ammonites as the Nautili do to the Ammonites; but the difference between them and the Ammonites is so little as must often be with difficulty discoverable.

Camerina. A shell with a single valve, without any external spire, the internal part divided into numerous chambers by imperforated septa. This genus was formed by Bruguiere for the reception of the fossil shells long known as Lapides lenticulares and Nummulites.

Rotalites. A depressed orbicular, discoidal chambered shell, smooth on the upper, radiated on the under side, with tubercular and unequal points in the centre; the edge carinated, and having a small trigonal marginal opening. The fossil shell on which this genus was formed, is figured and described by Guettard in his Memoirs on Fossils.

Turrilites. A spiral turbinated shell, with contiguous and visible turns, the sides articulated by winding sutures; transverse pierced septa, with foliated terminations; the opening round. The shells belonging to this genus are all fossil, and even the fragments of their casts are very rare. The characters of the shells of this genus are very striking, their internal structure being similar to that of the Ammonites, whilst they possess a turriculated or wreathed form.

Baculites. A straight cylindrical and rather conical shell; the sides articulated by winding sutures; the transverse septa terminating in foliaceous forms. This genus is founded on a fossil shell described by Faujas St. Fond in his Natural History of St. Peter's Mountain near Maestricht, and which he considers as a straight Ammonite.

Spirula. A shell partially or completely in a discoidal spire; the turns separate, and the last extending into a straight line; transverse smooth septa, pierced by a tube; the opening round. This genus comprises

also the Lituites, a fossil shell, bearing a very close resemblance, in form, to the recent shells of this genus, but very far exceeding them in size.

Belemnites, a many-chambered straight, long, conical pointed shell, full at its summit, and possessing a lateral cleft. These are only known in a mineral state.

Shell, in chemistry. Shells of marine animals, and of all eggs, consist chiefly of carbonate of lime, and yield a very pure lime, for which they are used on the sea-coast. They afford, likewise, a small portion of phosphate of lime. There are two great classes of marine shells, the testaceous and crustaceous. The former are by much the most numerous, and include all the marine shell animals that have not legs, and the power of transporting themselves from place to place. The crustaceous shells are those of the lobster, crab, prawn, &c. who carry their shell as a protection from external injury, and not as a place of residence. Mr. Hatchet has made many experiments on shells, and he observes, that marine shells for the most part are either of a porcellaneous aspect, with an enamelled surface and fibrous texture, or they are composed of the substance called nacre, or mother of pearl. The first kind dissolved in acids with strong effervescence, and their solutions afforded no trace of the phosphate of lime: they contained only carbonate of lime, and the animal matter, which acts as a cement to this, and which he supposes to be albumen in various states of induration: this is in small proportion, hence shells exposed to heat exhale but little empyreumatic animal odour, they emit no smoke, and when dissolved in acids no vestige of it can be discovered. In shells of the other description approaching to nacre, the earthy matter is carbonate of lime, but in a smaller proportion, while the animal matter is in considerable quantity. These give out smoke and an empyreumatic odour when exposed to heat, and when acted upon by acids, give out less carbonic acid gas, and leave a large quantity of a membranaceous or cartilaginous residuum. This substance often constitutes a large part of the shell, as in that of the oyster or muscle, and is so much indurated as to be no longer gelatinous, and in all shells of this division it appears to be deposited in layers, each having a corresponding coat of carbonate of lime.

Shells, in gunnery, are hollow iron balls to throw out of mortars or howitzers, with a fuze-hole of about an inch diameter, to load them with powder, and to receive the fuze: the bottom, or part opposite the fuze, is made heavier than the rest, that the fuze may fall uppermost, but in small elevations this is not always the case, nor is it necessary, for let it fall as it will, the fuze sets fire to the powder within, which bursts the shell, and causes great devastation. The shells had much better be made of an equal thickness, for then they burst into more pieces.

Shells, *message*, are nothing more than howitz shells, in the inside of which a letter, or other papers, are put. The fuze hole is stopped up with wood or cork, and the shells are fired out of a royal or howitz, either into a garrison or camp. It is supposed that the person to whom the letter is sent knows the time, and accordingly appoints a guard to look out for its arrival.

"To find the weight of a Shell." Rule. Double the difference of diameters of the shell and hollow sphere, and seven times the result gives the weight in pounds, cutting off the two right hand figures of whole numbers. Ex. Let the diameter of the shell be 13 inches, and that of the hollow sphere 9.5. Then the cube of 13 is 2197, and that of 9.5 is 857.357, the difference is 1339.625, its double is 2679.25, which multiplied by 7, gives 18754.625, and cutting off two places in whole numbers, the result is 187 *lb.* or 1 *cwt.* 2 *qrs.* 21 *lb.*, the weight of the shell.

Shell, a particular part of a sword, which serves as a shield to the hand when it grasps the hilt. The regulation sword, which is directed to be worn in a cross belt, has its shell so constructed that one side can fall down, by which means the hilt hangs more conveniently.

Shell, a short jacket without arms, which was worn by light dragoons, and in some instances by the infantry, before the new regulations took place, respecting the clothing of the British army. At the commencement of the present war, some militia colonels derived no inconsiderable emolument from this mode of dress.

SHELVES, in naval affairs, a general name given to any dangerous shallows, sand-banks, or rocks, lying immediately under the surface of the water.

SHERARDIA, in botany, so named in honour of William Sherard, LL.D. consul at Smyrna, a genus of the Tetrandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential cha-

racter: corolla one-petalled, funnel-form, superior; seeds two, three-toothed. There are three species.

SHERIFF. As keeper of the King's peace, the sheriff is the first man in the county, and superior in rank to any nobleman therein, during his office. He may apprehend and commit to prison all persons who break the peace, or attempt to break it, and may bind any one in a recognizance to keep the King's peace. He may, and is bound *ex officio*, to pursue and take all traitors, murderers, felons, and other misdoers, and commit them to gaol for safe custody. He is also to defend his country against any of the King's enemies, when they come into the land; and for this purpose, as well as for keeping the peace and pursuing felons, he may command all the people of his county to attend him, which is called the *posse comitatus*, or power of the county; which summons every person above fifteen years of age, and under the degree of a peer, is bound to attend, upon warning, on pain of fine and imprisonment. Yet he cannot exercise the office of a justice of the peace, for then this inconvenience would arise, that he should command himself to execute his own precepts.

The sheriff has a jurisdiction both in criminal and civil cases, and therefore he has two courts: his town court, for criminal causes, which is the King's court; the other is his county court, for civil causes, and this is the court of the sheriff himself. When the new sheriff is appointed and sworn, he ought, at or before the next county court, to deliver a writ of discharge to the old sheriff, who is to set over all the prisoners in the gaol, severally by their names (together with all the writs), precisely, by view and indenture between the two sheriffs; wherein must be comprehended all the actions which the old sheriff has against every prisoner, though the executions are of record; and till the delivery of the prisoners to the new sheriff, they remain in the custody of the old sheriff, notwithstanding the letters patent of appointment, the writ of discharge, and the writ of delivery. Neither is the new sheriff obliged to receive the prisoners, but at the gaol; but the office of the old sheriff ceases when the writ of discharge is brought to him.

By 3 George I. c. 15, it shall not be lawful for any person to buy, sell, let, or take to farm the office of under sheriff, or deputy sheriff, or seal keeper, county clerk, shire clerk, gaoler, bailiff, or any other office pertaining to the office of high sheriff, or to contract for any of the said offices, on forfeiture of 500*l.*; one moiety to his Majesty, the other to such as shall sue in any court at Westminster, within two years after the offence.

Provided that nothing in this act shall prevent any high sheriff from constituting an under sheriff, or deputy sheriff, as by law he may; nor to hinder the under sheriff in any case of the high sheriff's death, when he acts as high sheriff, from constituting a deputy; nor to hinder such sheriff, or under sheriff, from receiving the lawful perquisites of his office, or for taking security for the due answering the same; nor to hinder such sheriff or under sheriff, deputy sheriff, seal keeper, &c. from accounting to the high sheriff for all such lawful fees as shall be by them taken, nor for giving security so to do, or to hinder the high sheriff from allowing a salary to his under sheriff, &c. or other officers. And if any sheriff shall die before the expiration of his year, or before he be superseded, the under sheriff shall nevertheless continue in his office, and execute the same in the name of the deceased, till another sheriff be appointed and sworn; and the under sheriff shall be answerable for the execution of the office during such interval, as the high sheriff would have been; and the security given by the under sheriff and his pledges shall stand a security to the King, and all persons whatsoever, for the performing his office during such interval.

There is no particular qualification in lands required for the office of sheriff, but a sheriff cannot be elected to serve in parliament for the county of which he is sheriff. The under sheriff performs nearly all the duties of the sheriff. He is not to hold his office above one year, under the penalty of 200*l.* And no under sheriff or bailiff shall practice as an attorney; but this is so openly evaded, that no person is appointed under sheriff except an attorney.

SHIELD, an ancient weapon of defence, in the form of a light buckler, borne on the arm to turn off lances, darts, &c.

SHIELD, in heraldry, the escutcheon or field on which the bearings of coats of arms are placed.

SHILLING, an English silver coin, equal to 12 pence, or the 20th part of a pound sterling. This was a Saxon coin, being the 48th part of their pound weight. Its value at first was 5 pence; but it was reduced to 4 pence about a century before the conquest. After the conquest, the French solidus of 12 pence, which was in use among

the Normans, was called by the English name of shilling, and the Saxon shilling of 4 pence took a Norman name, and was called the groat, or great coin, because it was the largest English coin then known in England. From this time the shilling underwent many alterations. In the time of Edward I. the pound troy was the same as the pound sterling of silver, consisting of 20 shillings, so that the shilling weighed the 20th part of a pound, or more than half an ounce troy. But some are of opinion there were no coins of this denomination till Henry VII, in the year 1504, first coined silver pieces of 12 pence value, which we call shillings. Since the reign of Elizabeth a shilling weighs the 62d part of a pound troy, or 3 *dwts.* 20$\frac{8}{31}$ *grs.*, the pound weight of silver making 62 shillings. And hence the ounce of silver is worth 5*s.* 2*d.* or 5$\frac{1}{6}$ shillings.

SHINGLES, in building, small pieces of wood, or quartered oaken boards, sawn to a certain scantling, or, as is more usual, cleft to about an inch thick at one end, and made like wedges four or five inches broad, and eight or nine inches long. Shingles are also used instead of tiles or slates, especially for churches and steeples. However, this covering is dear, yet where tiles are very scarce, and a light covering is required, it is preferable to thatch, and where they are made of good oak, cleft, and not sawed, and well seasoned in water and the sun, they make a sure, light, and durable covering. The building is first to be covered all over with boards, and the shingles nailed upon them.

SHIP *building*. The man of science and the practical shipwright have long lamented, that in the theory of the art of ship-building there are so few fixed and positive principles established by demonstration, or confirmed by practice; thus the artist being left to the exercise of his own opinion in general, resists theoretical propositions, however speciously found, so hard has it ever been found to overcome habitual prejudices.

The great neglect of the theory of ship-building is much to be deplored in a country like this, where the practical part is so well understood and executed. Mathematics, engineering, and civil or house architect, are sciences nourished and taught in our universities and other schools, and however superior scholars may arrive in those arts, and celebrated for their abilities, show them shipping draughts, or talk to them of the science of ship-building, and they appear as much at a loss as though they had never heard of such an art; nevertheless, it may be but justice to add, that some men of different professions have felt themselves interested in its progress to perfection, and lately we have seen the endeavours of men conversant in the practical parts of ship-building, publishing their ideas, and this in hopes that gentlemen of more scientific abilities may be induced to add to their labours, and make the theory of ship-building much more familiar in this country, as few, very few, professional shipwrights have hitherto had it in their power to employ their talents to improve this science by theory.

Ships are bodies, which when to be put in motion, have water for their resisting force, and a contrary element, as air or wind, for their impelling force, therefore the theorist and practical ship-builder should ever keep particularly in view to improve himself in the knowledge of floating bodies, and endeavour to gain a complete knowledge of the resistance of fluids, add to this aerostatics and mathematics in general. Thus taught, the man of practice would, though cautiously, add the speculation of the theorist, as there is a great deal to be risked, and much to be suffered; but could the ideas of the theorist and the man of practice be assimilated and well weighed together, much benefit to the art of ship-building might be acquired, and their most useful ideas be reduced to the test of experiment.

When experience favours theory, then we arrive at the desired point, but the difficulty and expense of accurately making a sufficient number of experiments, is a great hindrance to its assumption, and has greatly hindered that desired knowledge in this branch of science. Notwithstanding these obstacles, many opportunities offer of introducing well digested theory, though cautiously and by degrees, into the many various ships and vessels building in this kingdom, and thus we would hope, by the united efforts of the theorist, ship-builder, and mariner, who should carefully notice and report every observation in his power of the vessel acting in her various situations, thus the different results being accurately stated, desirable data may be reasonably established.

It is well known that bodies of any magnitude could not be built or put together without designs or drawings on convenient scales, particularly that complex machine a ship, therefore an accurate delineation of the whole vessel, with respect to its various lengths, heighths, breadths, and depths, is

carefully represented by a drawing, called the sheer draught, the construction of which, with its several lines, &c. we shall endeavour as familiarly as possible to describe to our readers.

The principal dimensions, as they are generally termed, must be first decided upon, and they are the following, *viz.*

The length at the gun deck in ships of war, or distance between the extreme perpendiculars in merchant ships.

The extreme breadth, which is the thickness of the bottom plank on each side, added to the moulded breadth, or broadest part of the ship in midships.

Length of the keel for tonnage, which results from the extreme breadth and a length hereafter given.

Depth in hold, which must be always regulated by the properties required of the vessel.

Burthen in tons, resulting from the extreme breadth and length of the keel for tonnage, being multiplied into each other by a rule given hereafter.

Now these are called the principal dimensions, which we will endeavour to describe, with their concomitant circumstances, in their above order: and, first, the length on the gun-deck; this in ships of war must ever contain sufficient distance between the perpendiculars for all the ports, and room between each port for working the guns, and what may be required at the extremities, such as the manger at the forepart, and abaft room for the after-port, to come clear of the wing transom knee, &c. It will also appear evident that the distance between each port in the clear must contain space sufficient for two frame timbers and the filling timbers between, and the room or openings between the timbers. Thus we find by established practice the distance between, and size of the ports, in the following class of ships in the navy, are as follow:

	Guns.										Sloop.	
On the main deck, *viz.*	110		98		74		50		36		18	
	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
Foreside of the foremost port abaft the foremost perpendicular	11	6	11	4	7	0	17	6	10	6	6	9
Aft-side of the after port afore the after perpendicular	13	0	15	6	16	6	13	0	4	9	12	0
Ports deep	2	9	2	9	2	8	2	7	2	6	2	2
fore and aft	3	5	3	5	3	5	3	4	3	0	2	5
In distance from port to port *	7	9	7	9	7	6	7	10	7	0	6	11
In number on each side	16		15		15		11		13		10	
Thus we may find the most approved length on the gun-deck	193	0	188	8	180	0	146	0	137	0	110	0

	Tonnage of Merchant Ships.											
	1257		1000		818		544		441		329	
	Ft.	In.	Ft.	In	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
Foreside of the foremost port abaft the foremost perpendicular	22	6	22	0	22	0	14	6	31	0	6	6
Aft side of the after port afore the after perpendicular	14	6	13	6	13	4	12	6	Foreside well.		8	4
Ports deep	2	2	2	2	2	2	2	0	2	0	1	10
fore and aft	2	5	2	5	2	5	2	4	2	4	2	3
In distance from port to port*	8	3	8	3	8	3	7	6	6	0	7	6
In number on each side	13		12		12		11		10		10	
Thus we may find the most approved length between the perpendiculars of merchant ships	165	6	159	0	146	0	124	9	120	9	103	4

* Sometimes an additional timber is added between the ports at the gang-way, to make it the more convenient for the steps, &c.

The next dimension is the extreme breadth, and without repeating the proportions which various authors have mentioned, all alike erroneous as to fixed datas, we will give the extreme breadths of the above ships, which upon trial have been found to answer their intended purposes by that construction.

	Guns.										Sloop	
	110		98		74		50		36		18	
	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
Breadth, moulded	52	0	49	0	48	0	39	10	37	6	29	0
Breadth, extreme...........	52	10	49	10	48	8	40	6	38	2	29	6

	Tonnage of Merchant Ships.											
	1257		1000		818		544		441		329	
	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
Breadth, moulded	41	2	37	4	35	4	31	4	28	6	27	0
Breadth, extreme	42	0	38	0	36	0	32	0	29	0	27	6

The length of the keel for tonnage, as was before observed, is produced from the former dimension, and a length given by a rule, although long established, is very defective, and the tonnage or burthen of the vessel, as it is sometimes called, is said to be produced therefrom. It may be therefore readily seen that those two dimensions only cannot possibly give any true burthen, for those two dimensions may be alike in two vessels of the greatest difference in their construction imaginable, for one vessel may be so constructed from the same dimensions as to be very sharp under her load draught of water with a very quick rising, to possess the requisite qualities for fast sailing, as the sloop of war, while another vessel keeping the dimensions, the same may be constructed as full under water as the most burthensome merchant ships. Sometimes the production of this rule is called builders tonnage, as a contradistinction to the true tonnage, and by this result builders are paid a certain price per ton for building any vessel.

THE RULE FOR CASTING THE TONNAGE.

In the royal navy, is to take the length on a straight line along the lower side of the rabbit of the keel from a perpendicular or square from the back of the main stern post, at the height of the wing transom, to a perpendicular or square at the height of the upper deck (and middle deck of three-decked ships) from the fore-part of the stern. The only difference in merchant ships is to take this length as before from the back of the main post at the height of the wing transom to the same height forward to the fore side of the stern, then from the length between those perpendiculars subtract three-fifths of the extreme breadth for the rake forward, and two inches and a half for every foot the wing-transom is high above the lower part of the rabbit of the keel for the rake abaft. The remainder is the length of the keel for tonnage.

Although this is the dimension sought, yet to show the fallacy of acquiring this tonnage the whole of the rule shall be here subjoined.

Then multiply the length of the keel for tonnage by the extreme breadth, and the product by half that breadth, and divide the whole by 94; the quotient will be the tonnage.

This extreme breadth to be taken from the outside to the outside plank or thick-stuff, in the broadest part of the ship, either above, on, or below the wales, deducting from the said thickstuff or plank all that it exceeds the thickness of the plank of the bottom, which shall be accounted the extreme breadth, so that the moulding breadth, or breadth of the frame, will then be less than the extreme breadth so found.

The thickness of the bottom plank, see the foregoing dimensions.

By this rule, the following lengths of the keel for tonnage of the same class of ships, are found, of

Guns.	Ft.	In.	Tons.	Ft.	In.
110	158	10	1257	134	0
98	156	6	1000	131	0
74	148	8¼	818	118	8
50	119	9	544	100	0
36	115	3	441	98	8
18	90	8	329	82	0

Also their burthen in tons:

Guns.	Tons.	Guns.	Tons.
110	2358	50	1044
98	2067	36	877
74	1873	18	419

	Tons.
East India ships	1257
Ditto	1000
Ditto	818
West India ships	544
Ditto	441
Ditto	329

Hence, it is obvious, had the length and breadth of the ships in the royal navy, and those in the merchant-service, being the same, the tonnage would also have been the same, although the construction under water is so very different; therefore no dependance can be placed on those rules for the confirmation of the real burthen of vessels. And, as to builder's tonnage, it is equally as fallacious, because depth is not taken at all into consideration, and it is easy to imagine, that two vessels may, by this rule, be the same tonnage, and one some feet deeper than the other; consequently, what results to the builder, is to regulate his price accordingly. Hence, there remains scarcely one undeviating method in the construction of ships. We will allow, it is not to be expected to obtain any rule, in this particular, that would be quite exact; because the true burthen, or tonnage, a ship should carry, not only depends upon the cubical dimensions of the ship's bottom, but her own gravity with respect to the whole of the hull; and, in short, on the weight of every article which makes a part of the ship. Therefore, the nearest rule that approximates to the burthen different built vessels are found, by experience, to carry, should be adopted; as the fallacy of the rule in present use discovers no one thing whatever, as may be easily seen by any person, though a novice in the art of ship-building.

Lastly, the depth in hold, which, in naval ships, must be always governed by the height which the guns are intended to be above the water, and load-water line. As the depth is taken from the upper side of the limber-strake to the upper side of the lower deck beam in midships. In merchant-vessels, the depth in hold is regulated for the different cargoes that each may be designed to carry; and here, again, as there can be no certain rule observed, we will give the depth in hold of the same acknowledged superior vessels.

Guns.	Ft.	In.	Tons.	Ft.	In.
110	22	9	1200	17	0
98	21	0	1000	14	9
74	19	6	800	14	9
50	17	6	544	14	9
36	13	4	440	12	2
18	8	6	330	12	0

To these dimensions we shall add the load draught of water of the same ships.

	Guns.	Ft.	I.	Guns.	Ft.	I.	Guns.	Ft.	I.	Guns.	Ft.	I.	Guns.	Ft.	I.	Guns.	Ft.	I.
Afore	110	23	0	98	22	0	74	20	0	50	18	0	36	18	0	18	13	0
Abaft		24	0		23	0		20	6		18	9		20	0		14	6
	Tons.			Tons.			Tons.			Tons.			Tons.			Tons.		
Afore	1257	23	9	1000	21	0	818	20	0	544	17	6	440	16	0	330	14	3
Abaft		23	9		21	0		20	0		17	6		16	0		14	3

Thus, having gained a few of the first leading principles, we will proceed to show their utility in constructing what is called the sheer-draught; and the necessity of dividing the sheer-draught into three distinct plans will be evident by inspection.

First. The sheer-plan, called, in general architecture, the plan of elevation. This is a section of the ship, made by a vertical or perpendicular plane, passing through the middle line of the keel, stem, and stern-post, throughout the whole length of the ship.

Secondly. The half-breadth plan, called by architects the ground-plan. This plan consists of an horizontal view of the half-breadths of the water-lines, ribbands, main and top-breadths, half breadth of the rising,

ditto, by longitudinal curves, by which the several breadths are limited, and as they would appear to the eye, placed directly over, and looking down on, the aforesaid sections, whether cutting the solid (supposing a ship a solid body) either by horizontal, diagonal, or sheer planes.

Thirdly. The body-plan, or plan of projection, are the transverse sections of the ship, at the joint of every frame-timber, showing the half breadth of each frame-timber, as it stands perpendicularly to the two former plans: hence, the frames contained between ⊕, or the midship, that being the broadest frame, and the stem, are represented on the right-hand side, and the frames at aft ⊕ on the left hand of the middle line in the body plan, are respectively called the fore and after body.

It may be necessary to add, that in all these plans only one half of the ship is represented, as each side must be supposed to be exactly alike, and that they must be very accurately drawn to the dimensions given, which have all been examined by proper calculations, submitted to the most precise scrutiny, and the results have actually stood the best test, that is, experiment; the said ship having been really built, and found to answer every expectation. Now, in the clearest manner possible, we will endeavour to point out the utility of these plans, in the construction of the various curves that form the body of a ship, in their different points of view, whether transverse or longitudinally, as on the several plans they will present themselves in very different directions; for, although the horizontal water-lines are represented by curves in the half-breadth plan, they are straight lines in sheer and body plan, and so likewise the appearance of the timbers; for, although they present themselves as vertical curves in the body plan, they appear as straight lines in the sheer and half-breadth plan; these premises being well understood, we may proceed to the construction of these several plans; and first, in the

Sheer plan, draw the stem keel, sternpost, &c. thus: draw a straight line that shall represent the upper edge of the rabbit of the keel, more than the main half breadth of the vessel, above the lower edge of the paper, then to your right-hand square up the foremost perpendicular, allowing room to represent the head. Now, as the limits of our design will not admit of our continuing the dimensions of all the before-mentioned ships; and as only one can be selected to form the sheer draught, the 74 gun-ship is made choice of, as being, of all vessels, the most handsome, and arrived to the greatest perfection in the construction; therefore set aft 180 feet from the foremost perpendicular, and square up another, calling it the after perpendicular, which gives the length of the gun-deck, or first principal dimension. Then square up another perpendicular, 69.0 feet abaft the foremost one, which is the midship perpendicular marked ⊕ thus, and called dead flatt. Much has been said concerning the situation of this transverse section, it being the broadest part of the ship, and containing the greatest area of surface; its judicious disposal will certainly facilitate the velocity of the vessel. All have agreed, and experience has confirmed it, that its position should always be before the middle of the vessel's length, or its centre of gravity. The French say, about $\frac{7}{12}$ the length of the vessel from aft, and nearly there, may be its best position, as vessels, in general, have been found much better constructed since the midship has been fixed nearer the stem.

Set up from the upper edge of the keel, or rabbit, the height of the under side of the gundeck, at the middle line, or middle of the ship, which is 24 feet 5 inches at the foremost perpendicular, 22 feet at ⊕, and 25 feet 4 inches up the after perpendicular; having these three heights, the hang, or sheer of the deck may be obtained, all fore and aft, by a drawing-bow, the lath of which is pressed by its screws, until it intersects the said heights set up, as this is supposed to produce the arch of a circle equal to the sheer of the deck; the upper side of the deck is then shown, by a line drawn 4 inches above, and parallel to its under side. Then, when the under-side of the gun-deck intersects the foremost perpendicular, set forward 4 inches for the rabbit of the stem, and 7 inches afore the rabbit, for the fore-side of the stem, and 7 inches abaft the aft-side of the rabbit, for the aft-side of the stem, the whole making 18 inches, the moulding of the stem; then with a radius equal to 24 feet, half the moulded breadth, sweep an arch which will form the aft-side of the stem below the gun-deck, intersecting the line drawn for the upper edge of the rabbit of the keel; then lengthen the radius to the fore-side of the stem, and sweep a circle parallel to the aft-side; then sweep in the aft-side of the

rabbit, by the radius 24 feet, keeping the centre the same height above the upper edge of the rabbit on the keel, as there the aft-side of the rabbit on the stem at the gun-deck, and the rabbit of the keel, intersect each other, by carrying the centre 7 inches before the first, then describe the aft side of the rabbit, and by opening the radius 4 inches more, the fore-side of the rabbit will be parallel to the aft side, and the stem and rabbit shown below the lower-deck, except the boxing, or keel, which will be determined on hereafter, then set up from the upper edge of the rabbit of the keel, on the foremost perpendicular, 30 feet, the height of the upper part of the stem, and draw a horizontal line upon this line before the perpendicular, set off 15 inches, which is what the stem rakes forward at the head, thence draw a straight line, or one a little curving, to break in fair with the back of the foremost sweep, at gun-decks, and the fore side of the stem is complete, then draw another, 18 inches from, and parallel to, the fore-side, and the aft-side will be drawn; then by the same curve the rabbit may be continued up on the fore-side, to the head of the stem, as the aft-side of the rabbit may not be drawn higher than the underside of the wall.

Proceed to draw in the stern-post thus: before the after perpendicular, on the upper edge of the keel, set 7 inches, then set up the after perpendicular 27 feet from the upper edge of the keel, and draw a horizontal line, which is the upper side of the wing transom on that line abaft the perpendicular, set off 23 inches, then a straight line, drawn through those two spots, will represent the aft side of the stern post, then from the aft side of the stern-post, set forward on the upper side of the keel 2 feet 1 inch, and at the upper side of the wing transom 13 inches, a straight line drawn through these two spots will be the aft side of the rabbit, and another line, 4 inches parallel before it, will be the fore-side of the rabbit, which will intersect the perpendicular at the gun deck. The stern-post thus far described, would be sufficient at present, but, to complete it, set up 2 feet 8 inches above the upper side of the wing transom, and continue upwards the aft side, then, on a line parallel to the under-side of the deck, at that height set forward 20 inches, and from the aft-side 3 feet upon the upper side of the keel, a line drawn through those spots and the stern-post, will be represented from the head downwards. Draw another line before the fore-side of the post, on the keel, 16 inches, and at the under-side of the deck transom 13 inches, and the fore side of the inner post will be likewise represented. Thus we have the extremities of the ship below the main-breadth.

The height of breadth-lines are next to be drawn on the sheer plan, and there they determine the height of the broadest part of the ship, at each transverse section or timber, that nearest the keel, is called the lower height of breadth, and the one above, the upper height of breadth. The lower height of breadth in the midships generally is placed midway between the ports and the load-water line in naval ships, and rather above the load-water line in merchant-ships; its quick rise forward and aft is highly requisite for preserving a greater breadth above the load-water line, to assist and relieve the ship in her pitching and rolling motions in a heavy sea, lifting her forward, and making her lively, as the seamen call it. In order to set up the height of breadth-lines, it is necessary that the stations of several of the timbers should be set off between the perpendicular at ⊕, and the stem forward, and stern post abaft: here the timber and room, or room and space, must be determined, which is the distance between the moulding edges, or joints of every two timbers, and an interval of two or more inches between them; for here it may be observed, that in moulding the timbers, either before or abaft this joint or station, the moulds are made to the same line, as they are supposed to adjoin each other; but this method could not be true, supposing the timbers to be separated some distance apart, and it must be here also further observed, it being of the utmost consequence to the strength of the ship, that all the frame timbers should be preserved whole, and not cut or wounded by the ports, at the timbers appointed to make the sides of ports should run up to the top of the side, and are to be united or framed together into bends, before they are gotten up into their places in the ship: thus, those intended to make the sides of ports, are called frame-timbers; and those cut off under the ports, or between the frames, are called filling timbers, the third futtocks of which, to increase the strength, should run up to the under-sides of the ports, if possible.

The room and space of this ship is 2 feet 9 inches, consequently the distance of every

frame joint is 5 feet 6 inches; and it is at each of these stations that perpendiculars from the keel are drawn in the sheer plan: the timbers before ⊕ are alphabetically named A, B, C, &c., and those abaft ⊕, or dead flat, numerally, 1, 2, 3, &c. The timbers adjoining ⊕, which have no rising, are distinguished thus (A) (B), or (1) (2), and are likewise called flats.

In this ship ⊕ is a single timber, although it has been before observed this single timber is sometimes placed near the steps, or gangway. Observe, this single timber is introduced to change the bodies, as that before it is called the fore-body, so that abaft it is called the after-body: but this is not all, the floors in the fore-body are placed on the fore-side of the joint, consequently their moulding edge is on their aft side, and the floors in the after body are placed on the aftside the joint, and their moulding edge is on their foreside, therefore in both bodies they become under bevellings: hence the necessity of this single timber to effect this change, or two floors would come together at the turn of the body, and the joint at their heads not strengthened by this intermediate shift of timber.

Now, as we do not mean to square up perpendiculars at the joint of every frame timber, we shall make use of as many as will suit our purpose in delineating the sheer plan. Therefore set before the perpendicular ⊕ 19 feet 3 inches, and then square up from the upper edge of the keel a perpendicular, and under it mark F, as that is the station for frame F, then before F square up perpendiculars at 11 feet distant, marking under that next F, K, the next O, and the foremost one S. Then abaft the perpendicular ⊕ set off 24 feet 9 inches, and then square up a perpendicular, and mark under it 6, as that will be the station for frame 6; then abaft this perpendicular set off 16 feet 6 inches five times, and square up perpendiculars at each station, marking that next abaft 6, 12, the others in succession 18, 24, 30, and the after one 36. These perpendiculars, or stations, are always referred to by those names hereafter.

Above the upper edge of the rabbit of the keel set up upon the foremost perpendicular 29 feet, the height of breadth at the stem, as both heights of breadths are terminated at one place quite forward and aft; next set up at S 24 feet 2 inches, at O, 22 feet 8 inches, at K, 21 feet 10 inches, at F, 21 feet 3 inches, at ⊕, 21 feet 3 inches; at 6, 21 feet 3¼ inches; at 12, 21 feet 4 inches; at 18, 21 feet 6 inches; at 24, 22 feet 4 inches, at 30, 23 feet 9 inches, at 36, 26 feet 5 inches; and the after perpendicular, 27 feet 10 inches. Then an elliptical curve drawn through those heights will show the lower height of breadth all fore and aft.

The rising line is the next curve to be drawn in the sheer plan, which in a ship of this construction gives the heights of the centres of the floor sweeps, by the which curves the shape of the timbers at and near the floor heads are formed in the body plan; thus, set up, as before, at K 21 feet 4 inches, at F, 14 feet 7 inches, at ⊕, 11 feet 6 inches, at 6, 12 feet, at 12, 14 feet; at 18, 17 feet 6 inches, and at 24, 24 feet 11 inches.

Then an elliptical curve drawn through those heights will determine the centre heights of the floor sweeps, and although these lines may be termed imaginary lines, and not wanted in finishing the fabric, the necessity of drawing these lines, with their connected half breadths, &c. will appear, when we insist upon the nicety required in the formation of every line used in ship-building; and by thus representing them, the draftsman, or constructor, avails himself of an opportunity of observing that the said lines make fair curves. We said above, that the rising line in a ship of this construction gave the heights of the centres for forming the floor-sweeps, but in full-built ships, or merchant ships in general, this rising line gives the rising or lifting of the floors towards their heads, above which one radius is given for limiting their curves, and from this very line the whole construction or form of the body at this place is given. Now, in the formation of this line, no undeviating rule is given, therefore, to construct it, a general knowledge of the formation of various bodies of different vessels is absolutely necessary. But what follows may be unvariably observed, that is the lifting of this line on the sheer plan, and narrowing it on the half-breadth plan, will procure velocity and less capacity; while lowering it on the sheer plan, and continuing its midship part parallel with the keel, and augmenting its breadth on the half breadth, and continuing it in midships parallel with the middle line, will produce a full, or burthensome vessel, but then a vessel on this construction will not sail; hence the judgment required in constructing this part of the ship can only be acquired by practice.

Now the main half breadth, and the half-breadth of the rising of this ship, may be

drawn in the half-breadth plan: thus, draw a straight line, parallel to, and as much below the upper side of the keel, in the sheer plan, as will admit of the depth of the keels a scale of feet and inches, by which the whole is to be drawn, and rather more than the main-half-breadth at ⊕, and this line will represent the middle line of the half-breadth plan, and is so called: then square down upon this line the several perpendiculars from the sheer plan, and it will also there represent the several timbers as sections crossing the timbers in the sheer plan at right angles.

Then for the main half-breadth set up from the middle line, for S, 20 feet 4 inches; at O, 23 feet; at K, 23 feet 10 inches; at F, 23 feet 11 inches; at ⊕, 24 feet; at 6, 23 feet 11½ inches; at 12, 23 feet 11 inches; at 18, 23 feet 8 inches; at 24, 22 feet 9 inches; at 30, 20 feet 10 inches; and at 36, 17 feet 9 inches. Draw a curve through these several half-breadths, and the main half-breadth line will be described, except the fore and after parts. Permit us here to observe, the best method for drawing this, and all other lines partaking of the nature of curves, is by elliptical moulds; or what is better, when they are of any length, is by a thin pliable batten, confined down to the several spots, or dimensions, by square pieces of lead, about three or four ounces in weight; because by this last method the draughtsman has an opportunity of observing the fairness, or correctness, of the line before he draws it. Our readers will excuse this particular description, because it need not be repeated, as all lines hereafter are supposed to be drawn in the same manner.

Now, to end the main half-breadth forward proceed as follow: when the height of breadth cuts the fore part of the rabbit on the stem, square it down to the middle line of the half-breadth plan, by taking its nearest distance from the adjoining perpendicular, and setting off that distance in the same manner from the same perpendicular on the middle line in the half-breadth plan, and there square up a line; then set up on it 10 inches, the half-siding, or thickness, of the stem at that place; from the middle line then, with compasses opened to 4 inches, the thickness of the plank of the bottom, sweep aft from the half-thickness of the stem an arch; then with a radius equal 26 feet 6 inches will finish the fore-part of the main half-breadth line; from the following centre draw a line at 4 feet 4 inches below and parallel to the middle line of the half-breadth plan under timber O, and from timber O set forward 20 inches, and square it down to the line last drawn, and its intersection will be the centre required; then, with radius 26 feet 6 inches, sweep the segment of a circle from timber S till it will intersect the back of the arch at the thickness of the bottom plank; thus the main half-breadth line is completed, except the after end, which must be finished hereafter.

Next set off the half-breadth of the rising which limits the distance of the centres of the floor sweeps from the middle line on their respective heights in the body plan. Set up from the middle line of the half-breadth plan, at timber K, 2 feet 9 inches; at F, 7 feet 2 inches; at ⊕, 8 feet 6 inches; at 6, 8 feet 5 inches; at 12, 7 feet 6 inches; at 18, 5 feet 3¾ inches; and at 24, 8 inches; then drawing a curve through those spots, the half-breadth of the rising will be seen.

We may now proceed to drawing the vertical curve appearance those several timbers will form below the lower height of breadth line in the body plan. Continue aft the upper edge of the rabbit of the keel line, and on it square up a line about 40 feet abaft the after perpendicular, and call this the middle line; then at 24 feet distance, which is the main half-breadth at midships on each side the middle line, square up a side line; then, within the boundaries of ⊕, on the right hand, will be delineated the several timbers which compose the fore-body; and within ⊕, on the left, those of the after-body.

Now transfer the several heights of the lower height of breadth line from the sheer plan at and before ⊕, and set them up the side line in the fore-body plan, drawing horizontal lines across at those heights to the middle line; then take the several main half-breadths from ⊕, and forward from the middle line of the half-breadth plan, and set them off from the middle line on their corresponding heights of breadth last drawn in the fore-body plan, and the utmost limits, or main breadth, of each timber will be shown.

Now draw another curve in the half breadth plan which shall be the radius or length, whereby portions of circles are swept to form the shape of the body some distance below the main breadth. Set up from the middle line at ⊕ in the half breadth plan 18 feet 9 inches; at F, 18 feet; at K, 17 feet; at O, 15 feet 8 inches; at S, 18 feet 11 inches; at 6, 18 feet 9 inches; at 12, 18 feet

7 inches; at 18, 17 feet 2 inches; at 24, 15 feet 3 inches; at 30, 12 feet 3 inches; and at 36, 7 feet. Draw a fair curve through these spots, and the length of all the sweeps may be obtained, then transfer the length at ⊕ and the timbers before it, and set them off with the half breadth of their respective timbers on their corresponding height of breadth lines in the fore-body plan, sweeping arch about 9 feet below each height.

In the same manner transfer the heights for the centres of the floor-sweeps, from the sheer to the body-plan, and on those heights, from the middle line, set off the corresponding rising half breadths, their intersections being the centres from which each floor may be swept by the following radii, without its rising half breadth, the radius at ⊕ is 11 feet, and what this is above the upper-edge of the keel is called the dead rising. The radius at F is 13 feet 7 inches; at K, 20 feet, 3 inches. Then with a curved mould, sometimes called a reconciling sweep, (as in some bodies it might be a portion of a circle), placed so as to cut the back of the lower and floor-sweeps, the timber ⊕ will be represented almost to the keel, and so may the other timbers as far as K; then to complete them to the keel, set off the half siding of the keel, which is 9 inches, on each side the middle line in the body plan, below the line for its upper edge, and draw a line on each side parallel to the middle line; then with compasses, opened to 4 inches, make two arcs, on each side, from the upper side of the keel, to cross each other towards the middle line; draw a straight from the upper, and another from the lower, side of the rabbit, to intersect the arcs at equal angles, and the rabbit of the keel will be shown. Then a straight line, or a mould a little hollow, (sometimes called floor-hollow), placed to the siding of the keel at the upper-edge of the rabbit, and to cut the back of the floor-sweep, the timbers as far as K may be completed as far as the keel.

Now, as the other timbers approach the stem in the fore body, and those towards the stern post in the after body differ in shape materially from those timbers near the midships, it will be necessary to draw in several horizontal or water lines as they are called; for supposing the ship was floating on an even keel, and in an upright position, sections from side to side would thus be formed by the water. Here also we would show that every attention has been paid, and notice to our readers that vessels, in general, are found in their best sailing trim when they incline abaft from one to two feet, and sometimes more, particularly sharp constructed bodies, and that the upper one being the load-water line, is drawn to this inclination, and that the several water lines below it have been kept parallel thereto; thus in the common mode of representing the water lines, in the half breadth plan, their correct shape at those places was not accurately ascertained, and as it is not necessary they should be so drawn, horizontal lines are more preferable, and more useful; therefore draw in the sheer-plan five horizontal lines, above the upper edge of the keel, 3 feet 8 inches asunder.

Now as these lines are parallel to the keel, they will be shown by straight lines parallel to each other across the body plan; otherwise, were they inclined lines in the sheer plan, they would form curves at their heights in the body plan, but in either case they form curves in the half breadth plan, limiting the half breadth of the ship at the height of their corresponding lines in the sheer plan, and these being the lines, we are now about to represent, let their formation forward and aft be very nicely considered, for it is easy to conceive as they approach the keel, and finish into the stem and stern post, or vanish there, we may say they must taper very suddenly at those places, yet let not their form partake of hollow concave inflected curves, but as little as possible, and not at all forward, as it has been proved a mistaken notion of giving velocity. Proceed then, as before directed, to set off on each corresponding timber from the middle line of the half breadth plan the following half breadths, and first, for the upper or fifth water line, set off at S, 19 feet; at O, 22 feet 7 inches; at K, 23 feet 6 inches; at F, 23 feet 10 inches; at ⊕, 23 feet 11 inches; at 6, 23 feet 11 inches. Observe between 6 and F the water lines are kept parallel, or nearly so, to the main half breadth line: set off at 12, 23 feet 10½ inches; at 18, 23 feet 4 inches; at 24, 22 feet 3 inches; at 30, 19 feet 7 inches; and at 36, 8 feet 5 inches. Now to end the aft part correctly, square down, from the nearest perpendicular, where the aft side of the rabbit of the post is cut by the fifth or upper water line, in the sheer plan, down to the middle line of the half breadth plan, from whence square up a line, on which set up the half thickness of the stern post from the body plan; but in order to do this, set off the half thickness of the stern post from the middle line, in after body plan,

thus set off 11 inches at the head, and continue it parallel to the middle line, as low down as the deck transom, which is 2 feet 2 inches below the upper side of the wing transom, from thence it is to taper, with a straight line, to 7 inches on the upper side of the keel. Then the half thickness of the post may be taken at each water line, in the body plan, and set up from the middle line, in the half breadth plan to its corresponding ending, as squared down, from the sheer plan, where the water lines intersect the aft side of the rabbit on the stern post, then, with a radius of 4 inches, sweep an arch within the half thickness of the post, on the half breadth plan, and the water line ends, intersecting the back of the arch, and a line squared out from the back of the water line to cut the half siding of the post, would show the thickness of the bottom plank in that direction. Proceed to complete the fore part of the upper water line, with a 35 feet 6 inches radius, and ending of it similar as the main half breadth was, and, for the centre of the radius, draw an horizontal line at 11 feet 6 inches, under the middle line of the half breadth plan, with the above radius extended from the half breadth, or spot, given at timber S gives the centre, where it cuts the line last drawn; then sweep an arch from S, to the rabbit, will complete the upper water line.

Proceed to set off the several half breadths and endings of the fourth water line as before set up at S, 16 feet 8 inches; at O, 21 feet at K, 22 feet 5 inches, at F, 22 feet 10½ inches, at ⊕, 23 feet, at 6, 22 feet 11½ inches, at 12, 22 feet 10 inches, at 18, 22 feet 2 inches, at 24, 20 feet 8 inches, at 30, 16 feet 8 inches, and at 36, 2 feet 11 inches. To sweep the fore part draw a line under the middle line, in the half breadth plan, and parallel to it, at 21 feet 9 inches, then with a radius of 47 feet, from the half breadth at S, sweep in the fore part to the rabbit, as the paper on which the draught is drawn will not extend so low as this, in this case of sweeping in the fore part of half breadth lines an additional sheet is placed underneath for this purpose. Ending of the water lines being all the same abaft, refer to the ending of the upper water line.

Proceed to set off the several half breadths and endings of the third water line, at S, 12 feet 4 inches; at O, 15 feet 8 inches; at K, 20 feet 3 inches; at F, 21 feet, at ⊕, 21 feet 5 inches, at 6, 21 feet 4½ inches, at 12, 21 feet 1 inch, at 18, 20 feet 3 inches, at 24, 18 feet; at 30, 12 feet; and at 36, 1 foot 5 inches. We must here remark, that to complete this line forward with an arch, the radius would be too long for practice, it must therefore be finished by a mould or thin batten.

Proceed to set off the several half breadths and endings of the second water line. Set up at S, 7 feet 3 inches, at O, 13 feet 6 inches; at K, 17 feet 2 inches; at F, 18 feet 11 inches, at ⊕, 19 feet 3 inches; at 6, 19 feet 2½ inches; at 12, 18 feet 11 inches, at 18, 17 feet 8 inches, at 24, 14 feet 2 inches, at 30, 6 feet 2 inches, and at 36, 8 inches; draw it as the last.

Lastly, for the first or lower water line: set up at S, 3 feet; at O, 8 feet, at K, 12 feet 6 inches, at F, 15 feet 3 inches, at ⊕, 16 feet 2 inches, at 6, 16 feet 1 inch, at 12, 15 feet 5 inches; at 18, 13 feet 0½ inch, at 24, 7 feet; at 30, 2 feet 1 inch, and at 36, 4 inches.

Now all the water lines being drawn, in the half breadth plan, and their delicacy of shape, if we may so term it, well examined, we may proceed to show whether they will likewise make fair timbers in the body plan; thus transfer the several half breadths of the water lines, as taken at ⊕, and set them off from the middle line, on their corresponding water lines, in the fore body plan, which will be found to answer with the shape of ⊕, already drawn, then proceed in the same manner with the other timbers before ⊕, drawing curves through the several half breadths, and ending them at the keel to the inside of the rabbit, but as timber S, comes upon the stem in the sheer plan, the keeling will also come on the stem, in the body plan, therefore its height must be taken above the line, at the upper edge of the rabbit, as continued before the stem, to where timber S intersects the fore side of the rabbit on the stem, and transfer that height to the fore body plan, to intersect the half thickness of the stem above the base line, or upper edge of the rabbit; in midships then, with a radius of 4 inches, sweep an arch from that height within the half thickness of the stem, then a line drawn through the several half breadths of S, and ending over the back of the arch, at the keeling timber, S, will be drawn; and to complete the keel, draw a square line from the back of the timber to intersect the height of the keeling at the half thickness of the stem, and the timber S will be complete below the breadth. Thus, having the perpendicular fore and aft appearance of the several timbers in the fore body, they

may now be strictly examined, and any unfairness readily pointed out, again, as a further proof, square up perpendicular lines close forward, about 2 feet asunder or less, (the same may be done close aft hereafter, for the proof of the fairness of the water lines abaft), then transfer the several half breadths, as before, from the half breadth to the body plan, and if they make handsome curves in the body plan, when drawn, the water lines may be said to be constructed with exactness.

But it may be necessary here just to describe to our readers what is meant by the term fair, as it often occurs in the formation of the several lines, which is, that all the lines should please the eye, having no inequalities, but produce a beautiful line (one sense of the word fair), and this is not an incongruous term, for Hogarth calls a curve, or serpentine line, the line of beauty, of which no architecture has such a variety as that of a ship.

Now complete the topsides, or upper part of the body and sheer plan, above the lower height of breadth. Thus, set off the upper height of breadth, in the sheer plan', at 8, 25 feet 10 inches, at O, 24 feet 6 inches; at K, 23 feet 10 inches, at F, 23 feet 5 inches, at $\oplus$, 23 feet 4 inches, at 6, 23 feet [illegible] inches; at 12, 23 feet $4\frac{1}{2}$ inches, at 18, 23 feet 6 inches, at 24, [illegible] feet 1 inch, at 30, 25 feet, and at 36, 27 feet 1 inch, and at the after perpendicular 28 feet 3 inches. Then, by drawing a curve through those heights intersecting the lower height of breadth, forward and aft, the upper height of breadth line will be represented. Then transfer these heights from the sheer to the body plan, and thereat draw horizontal lines across the body plan, then square up the several timbers from the lower to the upper height of breadth, as between those heights the timbers are straight, and of one breadth. Then with a 15 feet radius, called the length of the upper breadth sweep, draw arches upwards, from the breadth squared up, and at that centre in each upper breadth line. Draw in the sheer plan the top-timber line, for it is at this height that the top side is limited to a certain breadth, called the top-timber breadth. Set up above the upper edge of the keel, in the sheer plan, at timber 8, 37 feet 3 inches, at O, 36 feet 9 inches, at K, 36 feet 1 inch, at F, 35 feet 8 inches, at $\oplus$, 35 feet 6 inches, at 6, 35 feet 9 inches, at 12, 36 feet 4 inches, at 18, 36 feet 11 inches; at 24, 37 feet 10 inches, at 30, 38 feet 10 inches, and at 36, 40 feet. Draw a curve through these heights, and that will be the top-timber line in the sheer plan. Then set off the several top-timber half breadths, in the half breadth plan, by setting up at 8, 20 feet 4 inches, at O, 21 feet, at K, 21 feet 11 inches, at F, 22 feet, at $\oplus$, 22 feet 2 inches, at 6, 22 feet $1\frac{1}{2}$ inch, at 12, 22 feet, at 18, 21 feet 7 inches; at 24, 20 feet 8 inches, at 30, 18 feet 10 inches; at 36, 16 feet, and at the after end, 12 feet, and at the fore end, or beak head, 17 feet. Draw a curve through these several half breadths, and the top timber half breadth will be represented. Transfer the several heights of the top-timber line from the sheer to the body plan, and at those heights draw horizontal lines; then from the half breadth plan transfer the several top-timber half breadths, and set them off from the middle line in the body plan upon their corresponding heights; then with a mould, about three inches curve (called the top-timber hollow), fixed well at the top-timber half breadth, and back of the upper sweep, at $\oplus$, draw a line to the top of the side, and $\oplus$ on the midship timber will be found from the keel to the gunwale.

Make a mould to $\oplus$, from the upper breadth upwards, some length above the gunwale, by which mould most of the timbers in the top-side may be drawn, by keeping them nearly parallel to each other, by so fixing the mould as to intersect the upper breadth sweep, and top timber half breadth. But observe the top-timbers as they approach the beak head in the fore-body, they flair out, or curve the reverse of the midship timbers, and considerably so in ships with a beak-head, this not only gives more room on the forecastle, but assists the catheads to cull the anchors clearer of the bow, and this flaring, though much less in other ships, has a tendency to keep off the spray of the sea, and make a dry forecastle.

Above the top-timber line in this ship, and sometimes at the plank sheer in others, the top-side is perpendicular, consequently an angle, called the knuckle, is formed at the intersection, and as many of the foremost timbers as partake of this shape, before they can be broken in fair with the others, are called knuckle timbers.

Forward and aft at the top-sides run higher than the top-timber line, set up their greatest heights to prove that their breadths at that place may make a fair line in the half breadth plan. Set up from F to forward, in the sheer plan, 2 feet 10 inches

above, and draw a line parallel to the top-timber line; and from 12 to 24, in the after-body, 4 feet 6 inches; and from 24, quite aft, 6 feet 6 inches; these risings above the gunwale, or the midships, are called drifts. Tranfer those heights from the sheer plan to intersect their corresponding timbers in the body plan, as they are then limited by curves parallel to the top-timber line, then transfer their several half breadths to their corresponding timbers in the half breadth plan, and if curves drawn through those breadths should prove fair, the top-side is rightly constructed; if otherwise, each must be altered until they agree.

What remains to be described relates equally to both the fore and after bodies; for their being thus far completed, we have an opportunity of shifting the several timbers to the various lengths that compose them from the keel upwards, such as the floors, futtocks, and top-timbers. First the length of the floors for a ship of this magnitude is 26 feet long at ⊕, or midships, and the lengths of those forward and aft may be determined by a diagonal line thus drawn in the body plan; set up the middle line above the upper edge of the keel 14 feet 6 inches, and on the base-line 14 feet on each side the middle line, draw lines to those spots, and the length of each floor is limited between those lines. Then to determine the heads or lengths of the lower or first futtocks, set up the middle as before 22 feet 10 inches, and along the base line on each side 24 feet, drawing diagonal lines as for the floors, and the length of the lower futtocks are limited from the side of the keel to the diagonal line at their heads. Then for lengths of the second futtocks, set up the middle line 28 feet 8 inches, and up each side line from the base 10 feet, and draw the diagonals and the lengths of the second futtocks as limited from their junction at the floor-head called the heel, to the diagonal last drawn or head. Then for the lengths of the third futtocks, set up the middle line 34 feet 8 inches, and up each side 18 feet 5 inches, then diagonals, when drawn to these spots, will limit the length of the third futtocks from its heel at the first head. The fourth futtocks, when they can be gotten, are in one length from the second futtock head to the top of the side, and the top-timbers from the third futtock head to the top of the side.

The heads of the timbers being shown in the body plan, direct the stations for the ribbands thus; place the floor ribband about 20 inches below the floor head, and parallel thereto; then the next or first futtock ribband about midway between the floor and first futtock heads, and so with the others, keeping their heights forward and aft, the most convenient for supporting the heads and heels of the timbers before they need be disturbed by working the planks outside.

Now these are called the ribband lines, and only appear as diagonal lines in the body plan, but they take their names from the ribbands, which are pieces of oak or fir timber, about 6 inches square, the longer the better; but those close forward and aft are called harpins, and are trimmed by moulds and bevellings to the form of the ship at those places. Ribband lines form curves on a ship's bottom by the intersection of a plane inclined, or canted, as shipwrights term it, to the plane of elevation, and their curves on the half breadth plan are denominated by them canted, or level, according as their several half breadths are taken off from the body plan, whether diagonally, or in a direction square from the middle line, which is a level, or perpendicular to the plan of elevation, and although they agree in one and the same line on the ship's bottom, they represent very different curves in the half breadth plan.

Draw the ribband line at the floor head, in the half breadth plan, by taking these several half breadths from the middle line of the body plan, in the direction of the ribband line; thus, we shall find ⊕, 16 feet; F, 15 feet 1 inch; K, 13 feet 11 inches; O, 10 feet 4 inches; and S, 8 feet 6 inches; in the fore body; and 6, 15 feet 9 inches; 12, 15 feet 1 inch; 18, 14 feet; 24, 11 feet 7 inches; 30, 7 feet 6 inches; and 36, 1 foot 1½ inches. Then set up these several half breadths on their corresponding timbers from the middle line in the half breadth plan; but what their endings differ from the water lines we will next explain. Take the height where the diagonal line, or ribband, cuts the half thickness of the stem in the body plan, and transfer that height to intersect the fore side of the rabbit of the stem in the sheer plan, from whence square down the fore side of the rabbit to the middle line in the half breadth plan, and then square up a line, then take the half thickness of the stem from the middle line in the body plan in the direction of the ribband line, and set it up from the middle line in the half breadth plan on the line last drawn, then with compasses take the breadth of

the rabbit in the direction of the ribband line, in the body plan, and sweep an arch from the half thickness of the stem, in the half breadth plan, and the back of the arch will be its ending forward; the ending abaft is so nearly the same, only that the heights are taken up the half thickness of the post in the body plan, and transferred to the aft side of the rabbit of the post in the sheer plan; proceed as before, now draw a curve line through all the half breadths, and intersecting the back of each arch, the ribband line at the floor head will be represented in the half breadth plan. In the same manner all the ribband lines may be represented. These lines will also prove the fairness of the bodies, but horizontal water lines should always have the preference, as they cut the body in a more acute direction, and its unfairness would be more readily discovered, for it is possible to have fair ribband lines to appearance, and the body itself remain unfair.

Hitherto the timbers have only been considered as perpendicular to the upper side of the keel, and square from the plane of elevation, or sheer plan, and hence called square timbers. But forward and aft in the turn of the body, they are canted, that is, they incline aft towards the middle line in the fore body, and forward in the after body in the half breadth plan, or form obtuse angles to the plane of elevation; the utility of this is to straighten the form of the timbers, and reduce the bevellings, both highly essential in the conversion. Now to determine the situation of the cant timbers in the fore body, the foremost cant timber, which is Y, should be so canted as to stand square with the main breadth line as possible, therefore it will lie on that line before timber 8, 15 feet 2 inches on a straight line, and at the side of the deadwood, which is 8 inches from, and parallel to, the middle line of the half breadth plan, 4 feet 10 inches before S; then the after cant timber, which is P, is before O at the main breadth, 2 feet 9 inches, and at the side of the dead-wood, 2 feet 4 inches, draw straight lines to those spots, and the cant of the foremost cant timber Y, and the after one P, will be represented on the half breadth plan, the intermediate ones, which are 7, may be drawn by equally dividing them at the dead-wood, between those already drawn, to where they shall intersect their respective square timbers at the main breadth line, as here they remain at the same station unless they are moved to make the side of a port.

The cant timbers in the after body may next be described in the half breadth plan, in order to which the cant of the fashion-piece, or after timber, must first be determined, observing, as in the fore body, to let it cant as nearly as possible square from the body at that place. Now as the fashion-piece comes against the fore side of the transoms, the wing transoms must be drawn in the half breadth plan, thus set off from the middle line in the half breadth plan at timber 36, 16 feet 6 inches the half breadth of the wing transom, from thence level out a line aft, then, from the sheer plan, square down the aft-side of the wing transom at the post to the middle line in the half breadth plan, and at the side, on to the line last levelled out, then an arch drawn through these two spots, whose centre of radius is in the middle line, will represent the aft-side of the wing transom. Then draw in a horizontal line, in the half breadth plan, from a line at the side of the wing transom transferred from the sheer to the body plan, which is similar to a water line, then, from the aft-side of the transom, set forward upon the line last drawn, about 16 inches, and that is the aft-side of the fashion piece at that place; then let the heel of it, setting off the half thickness of the dead wood as before, be set off before timber 36, 6 feet 2 inches, a line drawn through those spots is the aft-side appearance of the cant fashion piece; then set off the cant of the foremost cant timber, which is 29, thus, abaft square timber 28, set off 2 feet 9 inches on the main breadth line, and 22 inches at the side of the dead wood, drawing a line which will represent the foremost cant timber, 29; then equally divide the heels of seven more on the dead wood between those already drawn, and likewise on the main breadth line and the joints of all the cant timbers, will be represented in the half breadth plan.

It was observed above, that the wing transom was limited by the aft-side of the fashion piece, and so are all the other transoms, unless to assist their conversion by shortening those below the deck transom, which are six in number, by introducing fashion pieces abaft that already described.

Now, to complete the sheer plan, let the stern timber, or shape of the stern at the aft-side, be described thus, draw aft an horizontal line at the upper side of the wing

transom at the post, and above it set up 4 feet, and draw another horizontal line, which will be the height of the lower counter; then set up, from the wing transom, 7 feet 6 inches, drawing another horizontal line, which will be the height of the upper counter; then set off abaft the aft-side of the wing transom 6 feet 10 inches, and square it up the line at the height of the lower counter, and the intersection with the knuckle of the lower counter; then, from the said knuckle, draw a curve line about 5 inches hollow to intersect the upper-side of the wing transom at the fore-side of the rabbet on the stern post, and the lower counter will be represented at the middle line; then set off abaft the aft-side of the wing transom 8 feet 10 inches, and square up a line to the height of the upper counter, and their intersection will be the knuckle of the upper counter; then to the two knuckles draw a curve about 2 inches hollow, and that will represent the upper counter. Both counters being formed at the middle line, the upper part of the stern timber must be thus finished: set up, as before, 14 feet 7 inches, the height of the top-timber line aft, draw a horizontal line; then set off abaft the aft-side of the wing transom 11 feet, and square it up to the top-timber line, a straight line now drawn from the upper counter knuckle, and through the intersection at the top timber line, and the stern timber at the middle line is complete.

Then observe, as the stern in its breadth rounds two ways, that is both up and aft, the stern timber at the side will alter from that at the middle line, and must be thus drawn: take the round top of the upper counter, which is 10 inches, and set it below its knuckle at the middle timber in the sheer plan, and draw an horizontal line; then take the round aft, which is 16 inches (on a level), and set it forward from the knuckle of the middle timber, and square it down to the line last drawn, and where it intersects will be the knuckle of the upper counter at the side. In the same manner set down 8 inches for the round up, and forward 15 inches for the round aft, and that will be the knuckle of the lower counter at the side; then a curve being drawn similar to that at the middle timber from one knuckle to the other, will form the upper counter at the side; then to finish the lower counter at the side, set down 5 inches the round up, below the upper side of the wing transom in the sheer plan, and draw an horizontal line; then take 7 inches the round aft of the wing transom, and set it forward from the aft side of the wing transom upon its upper side, and square it down to the line last drawn, and the intersection will be the aft-side of the side stern timber; then a curve drawn similar to that at the middle from the side lower counter knuckle to the aft-side last set off, will represent the lower counter at the side. But as the straight line for the upper part of the side timber will not be parallel to that at the middle, owing to the stern narrowing upwards, its rake must be determined as follow: upon any straight line set off 26 feet 8 inches, the breadth of the stern at the upper counter, and at the middle set off 16 inches the round aft, then let an arch pass through this point and the half breadths of the stern on the line; this may be performed by a small drawing bow or a mould swept with a radius equal to that segment. Now set off 12 feet, the half breadth of the stern at the top timber line on each side the middle to intersect the round aft at the upper counter, and through these intersections draw a line parallel to the other, and the distance from the line last drawn to arch in the middle is the distance that the side stern timber is from the after timbers, at the height of the top-timber line; then a line drawn through this spot to the knuckle of the upper counter at the side, completes the side counter timber.

Now the fore and aft view of the side counter timber may be drawn in the body plan, representing the half breadth of the stern. Draw an horizontal line across the after body plan, at the height of the upper side of the wing transom at the middle, thereon set off the half breadth of the wing transom from the half breadth plan, and there square down a line, and on that line set down 5 inches, or what is the same thing, transfer the height of the wing transom at the side from the sheer plan; then sweep an arch to cut the upper side of the wing transom at the side and middle, the centre of the radius being found in the middle line of the body plan; then draw a horizontal line, as before, at the height of each knuckle transferred from the side timber in the sheer to the body plan; then transfer the heights of the knuckles of the middle stern timber from the sheer, up the middle line of the body plan; then to obtain the half breadth at each knuckle, the

horizontal lines should be run from their heights in the body, to the half breadth plan and their knuckles, squared down thereon from the sheer plan, and at those places their half breadth transferred to the body plan. Thus we should find the half breadth at the lower counter knuckle 14 feet 6 inches, and at the upper counter knuckle 13 feet 5 inches; then set off these half breadths on their corresponding horizontals from the middle line in the body plan, and by sweeping arches as at the wing transom, from the heights at the side and middle line, the round up of each counter would be represented; then draw an horizontal line in the body plan, at the height where the top timber line cuts the side stern timber in the sheer plan, and on it set off the half breadth of the top timber line, which is 12 feet, as taken from the half breadth plan. Draw another horizontal line in the body plan, at the height of the top side, and on it set off 11 feet, its half breadth; then draw a straight line from the knuckle at the upper counter and the two half breadths above it, and the upper part of the timber will be formed, and from thence to the lower counter the same line may be continued, only having it to curve between the knuckles; then to complete this timber between the knuckle at the lower counter and wing transom, three or more horizontal lines should be equally spaced and drawn across the body plan, then several half breadths taken and set off the half breadth plan, and curves drawn through them; then when these horizontal lines intersect the side stern timber in the sheer plan, they must be squared down to their corresponding lines drawn in the half breadth plan, and their several half breadths there taken and set off on their corresponding lines in the body plan; then a curve passing through those spots from the knuckle of the lower counter to the wing transom at the side, completes the side timber in the body plan.

Now to complete the half breadth plan and the main half breadth and top-timber line abaft, thus, square down to the half breadth plan where the height of breadth, the top-timber line, cuts the side stern timber in the sheer plan, and from thence transfer its height to the stern timber in the body plan, and there take its half breadth and set off from the middle line of the half breadth plan upon the line last squared, down which is its ending at the outside; from thence sweep a curve to the round aft of the stern at those places, and it is complete.

Now there only remains to complete the sheer plan, and the construction of the sheer draught or principal design will be completed; and first set up the heights and lengths of all the decks thus, above the upper side of the gun deck already drawn, set up 7 feet 1 inch all forward aft, and draw a curve parallel thereto, which will represent the under side of the upper deck, and another curve, drawn 3 inches above, and parallel thereto, will represent the upper side of the upper deck; then above the upper side of the upper deck set up 6 feet 7 inches at timber F, and forward to the beak head; then draw a curve through these heights, parallel to the upper decks, and that will be the under side of the forecastle; then draw another curve 3 inches parallel above it, and that will be the upper side. Again, set up at timber 6, above the upper side of the upper deck, 6 feet 7 inches, and at the middle stern timber, 6 feet 9 inches, and above those heights 3 inches, drawing curves as before, the quarter deck will be represented. Set up, at timber 24, above the upper side of the quarter deck, 6 feet 5 inches, and at the midship stern timber 6 feet 7 inches, and above those heights 2¼ inches, and the round house deck will be represented as well as the before mentioned at the middle line.

The ports next claim our attention, but before they can be drawn, the decks at the side must be represented, and to do this correctly, the round up of the beam in midships, or the longest, must be represented by the segment of a circle, as was lately observed for the round aft of the stern.

Transfer the height of gun deck at ⊕ in the sheer, to the body plan, and then take the half breadth of the midship timber and set it off twice on some straight line, and in the middle set-up 6 inches, the round-up of the gun deck, at that place, drawing an arch as before.

Then for the round of the deck, or the deck at the side in the sheer plan, set down below the under side of the middle, as already drawn at ⊕, 6 inches; and for the other timbers observe the following method: transfer the height of the under side of the deck from the sheer, to its corresponding timber in the body plan, taking then its half breadth and apply it from each side the middle to insersect the arch for the round-up of the beam at ⊕, drawing parallel lines to each intersection, then the distance taken

in the middle, from the lines at the several breadths, being set down on their corresponding timbers, from the under side of the gun deck in the sheer plan, and a curve there drawn to pass through these several spots, will represent the hang, or sheer of the gun-deck at the side, and thus may the round-up of each deck, at the side, be shown in the sheer plan, according to its round-up at the broadest place.

Now for the under side of the gun deck ports, draw a curve line, 2 feet 8 inches above the gun deck line, at the side, in the sheer plan; and another parallel line, drawn 2 feet 8 inches above the lower side, will show the upper side of the gun deck ports. Then for the fore side of the foremost port, set off 9 feet 5 inches before timber S, and for its aft-side 6 feet 5 inches. Then for the fore-side of all the ports abaft the fore one, set off 4 feet 5¼ inches before the joint of every other frame beginning at frame 32; then 3 feet 5 inches set off abaft each of their fore sides will give the aft side; then square up their sides between the lines drawn for their lower and upper sides and all the 15 ports for the gun deck will be represented.

Then draw the upper deck, at the side, as directed for the gun deck; and for the upper-deck ports two curves, parallel above the deck at the side, the lower one 2 feet 2 inches, and the upper line 2 feet 8 inches above that; then set off, before timber S, 4 feet 4 inches for the fore-side of the foremost port, and 3 feet abaft it for the aft-side, then continue to set off 3 feet, exactly midway, between each gun deck port, and one abaft the after gun deck port, and square up their sides, and 15 ports will be represented for the upper deck.

In the same manner must the quarter-deck and forecastle ports, and even those on the round-house, if any be drawn, keeping them at equal distances, as near as possible, as their situations must depend on keeping them clear of the shrouds. The quarter deck ports on each side are 7 in number, the lower side 23 inches above the deck, at the side 2 feet 7 inches deep, and 2 feet 10 inches fore and aft, and the same on the forecastle, only 3 in number.

Now the wales may be drawn in the sheer plan, and as the strength of the ship depends much on their situation, great care should be taken in not placing them so high as to be cut by the gun deck ports, and yet so placed as to take as many of the bolts as come through the gun deck knees as possible, and that they come as near on the broadest part of the ship as the foregoing circumstances will admit; therefore for the height of the lower edge, set up above the upper edge of the keel, at the fore-side of the rabbit at the stem, 22 feet 7 inches; at S, 21 feet 2 inches; at O, 20 feet 4 inches; at K, 19 feet 9 inches; at F, 19 feet; at ⊕, 18 feet 8 inches; at 6, 18 feet 8½ inches; at 12, 18 feet 10 inches; at 18, 19 feet 5 inches; at 24, 20 feet 4 inches; at 30, 21 feet 10 inches; and at 36, 23 feet 11 inches. Then a curve drawn through these heights will be the lower edge of the wale, and another curve drawn 4 feet 4 inches, parallel above it, will be the upper edge of the wale; but observe the lower edge of the wale close aft, curves up very quick, owing to the sudden turn of the body at that place.

The heights and breadths of the channel wales may be next drawn; and as it may be readily seen from their situation they are intended to strengthen the top side, they therefore must be placed as nearly as possible between the lower and upper deck ports, and their lower edge, along the midships, should be placed so low as only to prevent their being cut by the upper stops of the gun deck ports, to prevent the upper edge being wounded by the upper deck ports, afore and abaft, therefore for the height of the lower edge, set up above the upper edge of the keel, at the fore side of the rabbit on the stem, 30 feet; at S, 29 feet; at O, 28 feet 5 inches; at K, 27 feet 11 inches; at F, 27 feet 6 inches; at ⊕ 27 feet 3 inches; at 6, 27 feet 6 inches; at 12, 28 feet; at 18, 28 feet 8 inches; at 24, 29 feet 8 inches; at 30, 30 feet 7 inches; and at 36, 32 feet. Then a curve drawn through these heights will be the lower edge of the channel wale, and another curve drawn 2 feet, parallel above it, will be the upper edge, thus the channel wale will be represented.

Now to complete the top side, the several rails, drifts, &c. remain to be described. Therefore set forward, from the aft side of the middle stern timber, 51 feet, the length of the round-house, and this should be no longer than may be just sufficient for the necessary accommodations, as the shorter the round-house the lower the top side may be kept abaft; and likewise the stern, as a low snug stern always appears handsome, and is best, as a proof of this, and the objection of lofty quarters abaft, several ships in the navy have their round-houses taken

away, and the top sides cut down. Set up above the top timber line 6 feet 6 inches, and draw a curve at that height, parallel to the top timber line, from aft to the fore end of the round-house; then draw another line, 2½ inches, parallel above it, and that will represent the plank sheer as far as the round-house.

Then in order to lower the top side, in a handsome manner, as it approaches the waist, or lowest part, have a fall or trance at the fore end of the round-house, turned off, with an inverted scroll, upon the plank sheer of the quarter deck, the underside of which is 4 feet 6 inches above the top-timber line, and parallel to it, to 3 feet 6 inches before timber 12, draw another curve, parallel 2½ inches, above the under side, and the plank sheer thus far will be represented, and house the ports at the fore part of the quarter deck. Then near the gangway let there be another fall or break at the fore part of the quarter deck, its extent 11 feet 6 inches before timber 12; then set up 3 feet 5 inches above the top timber line, and draw a line parallel thereto, 6 feet 9 inches aft, and another line 2½ inches parallel above it, and the plank sheer will be completed from aft. Then set up 2 feet 11 inches above the top-timber line, and draw a curve, parallel thereto, to the first break before timber 12, and that will be the under side of the drift rail, and draw another line, parallel to 4½ inches above that, and it will complete the drift rail thus far; then continue the drift rail as far as the main drift, by keeping its under side 2 feet above, and parallel to the top-timber line; now finish the main drift at the fore part of the quarter deck with a scroll, and the plank sheer above it with an inverted scroll; then complete the drift rail and plank sheer at the next break, with a quarter round.

Then above the round-house, at the side, set up 4 feet 1 inch, and draw a curve parallel thereto, which will be the under side of the rough tree rail, and a line drawn 4½ inches above, will show the thickness, or upper side, under which four ports, on each side, about 6 feet 4 inches asunder, and 3 feet 4 inches fore and aft, may be drawn, observing they are clear of the mizen shrouds, and the after port clear of the upper finishing of the quarter gallery.

Now that the top side of the ship, forward, should bear a resemblance to the after part, and in order to give security to the forecastle, set up above the top timber line, 2 feet 10 inches, and draw a curve, parallel thereto, from the fore side of the beak head to the aft part of the forecastle, and another line 2½ inches above, and parallel to the last, and the forecastle plank sheer will be represented; observe the after part of the forecastle is 4 feet 8 inches abaft timber F, and the fore side of the beak head 10 feet 3 inches before timber S; then draw the under side of the drift rail 22 inches above, and parallel to the top-timber line, and a line 4½ inches above it will complete the drift rail, and the drift is to be finished like the drift at the fore part of the quarter deck. Then the ports, 3 in number, 2 feet 10 inches fore and aft, are represented by timber heads, as their situations must be governed by the fore shrouds; the height of the timber heads are 22 inches above the plank sheer, one timber head being left to form the side of each port, and one between, and three or four before the foremast, will be quite sufficient, and there may be two similar timber heads left up abreast the main mast.

The sheer rail is represented by the top timber line, and a curve drawn to 5 inches parallel above it, and the waist rail by curves 5½ inches asunder, drawn parallel below the sheer rail, at 22 inches in the clear. The rails and drifts being merely ornamental, they are often dispensed with in the navy, as the sides of the ship were found to decay very fast under them. Some have them painted only along the sides, but merchant ships, in general, have them wrought solid in the plank of the top side.

The channels may next be situated as the shrouds leading to them were lately mentioned, with regard to spacing the quarter deck and forecastle ports; and first, the centres and rake of the masts must be drawn in the sheer plan. The centre of the fore mast is 22 feet abaft the aft side of the stem on the gun deck and rakes, or inclines aft, from a perpendicular, with the upper side of the keel ⅛ of an inch, in every yard of its length from the centre given. The centre of the main mast is 102 feet abaft the aft side of the stem, on the gun deck and rakes ⅜ of an inch in every yard of its length. And the centre of the mizen mast is 27 feet before the fore side of the rabbit of the stern post, on the gun deck and rakes aft ¾ of an inch in every yard of its length. Now let the upper edges of all the channels be kept well with the upper edge of the sheer rail, but in some ships the mizen channel is kept higher than the others, the better to station the quarter deck ports.

The length of the fore channel is 35 feet

6 inches, and its fore end fixed 3 feet 4 inches before the centre of the fore mast at that place. The length of the main channel is 29 feet 4 inches, and its fore end 3 inches before the centre of the main mast. The length of the mizen channel is 16 feet 6 inches, and its fore end 1 inch before the centre of the mizen mast. The outer edges of the fore and main channels is 4½ inches thick, and outer edge of mizen channel 3½ inches thick, which thicknesses may be drawn parallel their whole length below the upper side. The dead-eyes, that is, their diameters, which are 16 inches the main and fore, and 11 inches the mizen, may next be drawn, observing to place their centres that the rake of the chains may be clear of the upper deck ports, both chains and preventer plates to rake in the direction of their shrouds, which is best done in the following manner: continue upwards, through the centre, the rake of the mast to the upper side of the tressle trees, which for the fore mast is 87 feet above the keelson, then draw a line about 2 inches more than half their diameter above, and parallel to the upper side of the fore channel; then on this line fix the centre of the fore dead eye 10 inches abaft the centre of the fore mast, and the centre of the second dead eye 3 feet 9 inches abaft the foremost one's centre, and the centre of the third, fourth, and fifth, 2 feet 2 inches asunder, then lines drawn straight their centres, and crossing the height set up the mast, gives the proper rake of each dead-eye, chains, and preventer plate; and although there are eleven dead-eyes in the fore channel, their rakes and centres must be governed by the ports. The same rule must be observed in raking the dead-eye for the top mast, backstay, &c. adding the height of the top mast to the lower part of the head.

In the main channel are 12 dead-eyes, the centre of the foremost dead eye to be fixed at 12 inches abaft the centre of the main mast, and the centres of the remaining dead eyes may be stationed four between each port, raking them by the same process of those in the fore-channel.

Here the main-top-mast, and top-gallant backstay dead eyes, had much better be fixed on a stool, kept the height of the drift-sail above, as they will not only clear the ports better, but save a great and unnecessary consumption, in lengthening the main-channel.

Lastly, the mizen-channel, having 7 dead-eyes, the four foremost ones are stationed between the quarter-deck ports, next abaft the mizen-mast; and the other three, and mizen-topmast backstay dead eye, is stationed between the two next ports, fixing the centre of the foremost dead eye about 4 inches abaft the centre of the mizen-mast, raking them as before described.

The keelson being lately mentioned, and not drawn before, let it be represented in the sheer plan thus; first, draw in the cutting-down line, which is a curve that limits the height of every floor-timber, in the middle and the upper part of the dead or rising wood, forward and abaft, and the underside of the keelson. Set up at timber S, 4 feet 6 inches, at O, 2 feet 11 inches; at K, 2 feet 2 inches, at F, 2 feet ¼ inch, at ⊕, 2 feet; at 6, 2 feet ¼ inch; at 12, 2 feet ¾ inch; at 18, 2 feet 3 inches, at 24, 3 feet 3 inches; and at 30, 6 feet. Draw a curve through these spots, and another at 18 inches, parallel above it, and the keelson will be thus far shown, but as the fore part scarphs into the stemson, that must likewise be represented, and first, by drawing a curve 11 inches parallel, abaft the aft side of the stem, from the head to timber O, we show the apron or inner stem; then another curve, drawn abaft the apron, 13 inches, at the under side of the upper deck, and to break in fair with the upper side of the keelson, will represent the stemson. The after-end of the keelson scarphs into the knee, against the foreside of the transoms.

We may now proceed to draw in that ornamental and useful part of the ship, called the head; and here beauty and lightness should be most considered. Draw in the under side of the bowsprit, as that confines the height of the figure, set up above the upper side of the upper deck, at the aft side of the stem, 2 feet 11 inches; and then draw a perpendicular, at 15 feet 8 inches before the fore side of the stem, at the upper part, which will limit the fore side of the figure; set up thereon, above the upper side of the keel, 42 feet 3 inches; then draw a straight line through these two heights, and it will represent the under side of the bowsprit, and another line drawn parallel above it, at 3 feet distance on a square, will show the diameter or upper side of the bowsprit. Now draw the knightheads, and let them be sufficiently in height as to admit a chock over the bowsprit, so as to secure it firm in its bed on the stem: to do this, we must first draw half the diameter of the bowsprit, parallel to the middle line of the half breadth plan, and thereon square

down the fore side of the rabbit of the stern, at the underside of the bowsprit, in the sheer plan, and there draw a section of the knighthead, about two inches within the bowsprit, as they must not be cut any more by the bowsprit, then by squaring up the fore sides and the aft side of the section, from the half breadth plan, to and above the stem in the sheer plan; and, drawing lines parallel to the fore side of the rabbit, 4 feet 4 inches above the head of the stern, and the starboard knighthead will be represented.

The limits of the beak head should next be drawn thus. in the sheer plan draw a perpendicular, 6 feet abaft the aft side of the stem, at the upper part, and that will be the fore side of the beak head, set up above the upper side of the upper deck 20 inches, and draw a horizontal line from the fore side of the back head to the stem.

The cheeks being the basis of the head, their situation demands peculiar care, especially as the hawse holes come between them; therefore, before we can determine the situation of the lower cheek, the hawse-holes must be drawn in the half breadth plan, and squared up to the sheer plan; then set up, for their under sides, 2 feet 3 inches above the upper side of the upper deck, and 3 feet 8 inches for their upper sides; then the outsides of the hawse holes may be drawn in the sheer plan, and we shall see that the cheeks, as here to be drawn, are rightly situated: thus, for the underside of the lower cheek, set up from the upper edge of the keel, in the sheer-plan, 25 feet, on the fore side of the rabbit, on the stem, and from thence draw an airy curve, rising, to break in fair with the perpendicular, at the fore side of the figure, near to the head or upper part; and this curve will represent the fore side or set of the figure. Abaft the stem, the cheek may be drawn to the sheer of the wale, to 4 feet 4 inches, its after end. The upper side of the upper cheek may be exactly in the middle, between the lower side of the lower cheek, and the upper side of the main rail, the upper side of which is kept on a level with the beak head at the stem, then set down on the stem, below the upper side of the upper cheek, 11 inches, its siding or lower edge. Then draw a parallel line, 4 feet 4 inches abaft the perpendicular line, at the fore side of the figure, that will give the boundary of the hair bracket, except the scroll, and likewise the aft-side of the figure; the scroll which finishes the upper part of the hair bracket, should be gracefully turned over into the lower part of the neck, or between the shoulders of the figure. Square up a line from the after end of the lower cheek, to the upper cheek, and then draw another curve line from the under side of the upper cheek at the stem, the after part kept nearly parallel to the flight of the lower cheek, gradually rising, to break in fair with the perpendicular last drawn, and the under side of the upper cheek will now be represented. Then set off the heel of the figure, or length of the block from which the figure is to be carved, by squaring up a line from the under side of the lower cheek to the under side of the upper cheek, 7 feet 3 inches abaft the perpendicular, at the fore side of the figure. Then to draw in the siding or upper sides of the cheeks, set up 12 inches, the siding of the lower cheek above its lower side at the stem, and 9 inches at the heel of the figure, or foremost end of the lower cheek; then a curve drawn to a regular taper through those spots, describes the upper side of the lower cheek. In the same, draw in the upper side of the upper cheek, tapering regularly from 11 inches, its siding at the stem to 7 inches, its siding at the heel of the figure, or lower end of the hair bracket, the upper part of which at the scroll, may be 5 inches, the hair bracket should be completed by a pleasing serpentine line, finishing with the scroll before observed. The head of the block, or upper part of the figure, may be completed by continuing the line at the breast of the figure, rounding it to the top of the hair bracket, which is 37 feet 6 inches above the upper side of the keel, observing to keep the upper part of the figure 6 inches below the under side of the bowsprit.

Having fixed on the upper side of the main rail at the stern, continue the bag or upper side of it level with the beak head, as far out as possible, for the conveniency of the gratings, gradually rising the foremost end nearly parallel with the flight of the upper cheek, terminating the foremost end into the scroll of the hair bracket; to complete the after end, describe the arch of a circle that shall break in fair with the fore side of the beak head at the forecastle, and its upper side at the stem; the under side of the main rail is drawn by regularly tapering it from 12 inches, its moulding at the forecastle; to 7 inches, its moulding at the fore end; then continue the head of the main rail 2 feet 6 inches above the plank

sheer, corresponding with the fore side of the beak-head and it is complete.

The stations of the head-timbers may next be drawn thus: place the stem timber, or that nearest the stem, which is 7 inches, sided half its siding before the stem, and parallel to it, from the upper side of the upper cheek, to the under side of the main-rail; then fix the fore side of the foremost head timber on the upper side of the upper cheek, well with the heel of the figure, raking it forward its siding, which is 5 inches. The middle timber, which is sided 6 inches, may be now drawn exactly between the former two.

The two middle rails, between the main-rail and upper cheek, may be next drawn, by dividing the distance equally between the latter at every head timber, curves then drawn, regularly tapering, as before, to their mouldings; they may be thus represented, as far aft as the side, which terminates the after-end of the lower rail, about two feet abaft the stem timbers; and it may be now said, the rail above it also, as most ships now have the supporters under the cat-heads, to hang plumb, or nearly so; and although this may not finish quite so handsome as the rail continuing aft, and making the supporter, yet it is much stronger for supporting the cat-heads; but we shall here describe its method of ending, as has been usual, and the cat-head must be shown in the sheer plan; and in order to do this, it must be first drawn in the half breadth plan; thus square down the aft-side of the main-rail, or beak-head timber, from the sheer to the half breadth plan, squaring it across; and another line, 18 inches abaft it, which will be the fore-side, and the latter, the after side of the cat-head, as upon the forecastle; then from the intersection of the fore side of the cat-head, with the outside plank, at the top-timber, half breadth, or upper side of the forecastle, at the side, sweep a curve, at 9 feet distant, or without the bow; for at this place the cat-head cuts the sheer; then square up a line that shall cut the arch last drawn, at 5 feet before the fore side of the cat-head; then a line drawn from its intersection, to where the fore side of the cat-head cuts the outside plank, shows what the cat-head casts forward; then a parallel line, drawn at 18 inches abaft it, on a square, will be the aft side, and to complete the cat-head on the half breadth plan, square the outer end. Now square upwards to the forecastle on the sheer plan, where the aft side of the cat-head cuts the outside plank on the half breadth plan, and likewise its outer ends; then level out a line where the cat-head cuts the upper side of the forecastle; at the side above this line set up 3 feet 10 inches on the perpendicular, squared up for the aft side at the outer end; then from that spot draw a line to intersect the aft side of the cat-head at the forecastle; and that will be the under side of the cat-head, showing what it stives in its length upwards; then draw a parallel line above that to 16½ inches, and the aft side of the cat-head will be shown; then join the perpendiculars at the outer end, agreeably to the sheer, and draw a line at the fore side, parallel to the aft side, and the under side of the cat-head will be represented. In the half breadth plan, draw the supporter under the cat-head, what it is to project the bow, which is 6 feet 6 inches, and its siding 10 inches, placing it in the middle of the cat-head; then square up its length and aft side to the under side of the cat-head, in the sheer plan, and draw a line parallel to the aft side of the cat-head, from thence to the side its distance from the aft side of the cat-head. Then continue upwards the under side of the upper middle rail, with a curve parallel, or nearly so, to the aft side of the main rail; then draw the outer end of the supporter to the shape of a knee, and finish thereto the after end of the upper middle rail with a pleasing curve, resembling the after end of the main rail.

The knee of the head, or cutwater, remains now to be described. Let it project from the seating of the figure about 3 inches, which is at 35 feet 6 inches above the upper side of the keel; then draw a line across to the hair bracket with the sheer, and continue the upper side of the knee, or its cutting down, about 4 inches above, and parallel to the upper side of the upper cheek. Observe, in shaping the fore-part of the knee downwards, it be not too full, as it is then liable to rub the cable very much; therefore let it not project; the foreside of the lower cheek only to have sufficient substance for the bobstay holes, which are 4 inches diameter. When the lower side of the lower cheek cuts the foreside of the stem, with a radius of 5 feet 4 inches, sweep an arch; then draw a handsome serpentine line from its projection, at the seat of the figure, downwards, that may cut the back of the arch last drawn, and its breadth at the upper water line, which is two feet before the stem at that place, continuing it downwards, nearer the stem, until it forms the gripe, which partakes of a circle of

feet radius as it approaches the fore end of the keel. Therefore let the keel be completed: its upper edge here is represented by the upper edge of the rabbit: but this is not the case in all ships, for East India ships have the rabbit in the middle of the keel as well as in the middle of the stem; but observe, all heights are set up above the line representing the upper edge of the rabbit, whether in the middle of the keel or upper edge. Set down 18 inches from the upper edge of the keel, and draw a straight line parallel thereto, which represents the under edge of the main keel, then below that set down 5 inches, and drawing another parallel line, the false keel will be likewise represented. To limit the foremost end of the keel, square up a line as shall intersect the fore-side of the stem, leaving as much of the keel below the stem as it is deep in midships, at least from thence square a line across the stem, and it will limit the fore-foot, and the keel must there be that depth at least to receive the lower part of the stem, which boxes into it with a scarph, as follow: set off from the fore end of the keel 6 feet 6 inches, the length the stem scarphs into the keel; and that the stem, by keeping its moulded breadth, should not wound the keel too much at its lower edge, let the under side of the stem be cut off parallel with the under side of the keel two feet from its after end. The false keel may project the main keel about three inches, to which the lower part of the gripe will unite, and be limited by the fore-foot.

The scale which is drawn between the keel and half breadth plan we shall here describe, and very briefly, as most draughtsmen are acquainted with scales of this kind. Shipping draughts, in general, are drawn by a scale of one-fourth of an inch to every foot, in the length on the gun-deck, or between the perpendiculars; and the inches, at each end, divided into twelve parts, by seven lines drawn parallel to each other between the under side of the keel and the main half-breadth, and one foot, or division, at each end, beyond the perpendiculars, are divided each way in the middle by two diagonal lines, which produce 12 equal parts, or inches. Sometimes this scale is constructed with five lines, and the foot at each end divided into inches by three equal diagonal divisions, the thick, dark line, representing the under side of the keel, is generally continued round the scale by way of ornament.

Now, to proceed to finish the stem, quarter-galleries, &c.: first draw in the aft side of the quarter-piece at the outside, which you will find by the rounding of the stern, to come 13 inches before the upper counter knuckle of the side stern timber, setting it off as before directed; then draw a line with pencil, for the present, parallel to the side stern timber upwards, as the projection of the outside of the quarter gallery is nearly parallel to the side, except towards the upper part of the quarter piece. Then draw the projection of the upper counter rail at the knuckle of the middle stern timber, thus: draw a line, $2\frac{1}{2}$ inches parallel, abaft the upper counter at the middle, which will represent the thickness of the plank of the upper counter; then draw the under side of the rail, square from the upper counter, and to project enough to bury the plank in a rabbit, from thence set up 8 inches, the breadth of the rail, and to intersect it set off 7 inches, its thickness, drawing the upper side to the sheer; then from this projection draw lines parallel to the knuckles, till they intersect the line drawn for the aftside of the quarter piece, thus the round up of the aftside of the upper counter rail will be represented in the sheer plan. From the intersection of the upper side of the upper counter rail with the aft side of the quarter-piece draw a straight line forwards, parallel with the sheer, or top-timber line, and that will represent the upper edge of the lower gallery rim; upon that line set off before the quarter piece 16 feet 9 inches, the length of it on the side, then the underside of the rim will be shown by a line drawn parallel to 8 inches below it.

In the same manner draw a section of the lower counter rail, its under side to be square from the knuckle of the lower counter at the middle stern timber, and to project enough to bury the plank of the lower counter, the thickness of which will be represented by drawing a line to 4 inches parallel, abaft the lower counter, at the middle, from thence set up the breadth of it, which is $8\frac{1}{2}$ inches, and thereto project 8 inches, its thickness; from thence draw lines parallel to the knuckles of the lower counter to the counter at the side, drawn parallel, what the quarter piece projects, or as much as the lower counter rail rounds forward at the outside; then draw a line 2 feet 10 inches below, and parallel to the upper side of the lower gallery rim, and another likewise $8\frac{1}{2}$ inches below it, and that will show the lower counter rail, as continued round the quarters, called the lower stool

rail; set off from its aft side 13 feet, the length of this rail on the quarter. Then draw in the lower finishing, which should be as light and airy as possible: and first set down 10 inches below the rail last drawn, and draw a line parallel thereto, and another also 4 inches below it, which is the thickness of the stool. Draw a line parallel to the rake of the quarter-piece, at 7 feet 11 inches, set off square before it, and this will give the rake of the quarter in the middle of the lower gallery, and likewise the middle of the lower finishing. Set down 13 inches below the stool, and in the direction on the line last drawn, then draw a handsome serpentine line from the under side of the lower counter-rail at the side, through the spot last set off, continuing it upwards nearly to the fore end of the lower stool rail, the lower finishing will be completed; and then draw a curve 4 inches abaft, and parallel to the lower counter at the side, and the stern will be finished below the lower gallery rim.

Then set up the aft side of the quarter-piece, and with the rake from the upper edge of the lower gallery rim, 5 feet, and draw a line along the quarter parallel to the sheer, or lower gallery rim, and another line in the same direction 8 inches above it, and its length, 16 feet 9 inches, from the aft side of the quarter piece, and that will represent the middle stool rail, and a continuation of the foot-space rail from aft round the quarters. Hitherto the quarter piece has been considered as one length, from the upper part to the lower gallery rim, but as that would make it very heavy, and of an unnecessary length, let its heel, or lower end, terminate on the middle stool.

Now set forward the siding of the quarter-piece, which is 16 inches, on a square, and draw a line to that siding parallel to the aft-side, which represents the fore side of the quarter piece, continue down the fore-side line from the under side of the middle stool rail to the upper side of the lower rim rail. Then set up the fore side of the quarter-piece on the rake, 3 feet 2 inches above the upper edge of the lower rim rail, and above that 7½ inches, and draw two lines forward, parallel to the lower rim, to 12 feet 2 inches before the fore side of the quarter-piece, and they will represent the upper gallery rim. Then above the upper rim, and parallel to it, draw the upper stool rail thus, set up the fore side of the quarter-piece, and on the rake 3 feet 10 inches from the upper edge of the upper rim, and 6½ inches, its depth above it, and draw two parallel lines from thence to 12 feet 2 inches before the fore side of the quarter-piece. Above the upper stool draw the upper finishing thus: set up the rake at the fore side of the quarter-piece, 12 inches from the upper side of the upper stool, and below that height 4 inches; then draw two lines from thence, parallel to the upper stool, to 10 feet 8 inches before the fore side of the quarter-piece in the same manner, and from the same place as above set 23 inches, and 2½ inches below it, and the pulpit rail, or upper rail of the finish, will be found to answer with the height of the plank sheer; then set forward from the fore side of the quarter-piece 10 feet 2 inches; then draw between those two rails a line parallel to the rake of the quarter, about 3 inches within the forwards; then finish the fore part of the quarter from the under side of the middle rail of the upper finishing to the upper side of the upper stool rail at the fore part by an ogee curve, and the upper finishing will be complete.

Now, as the upper rim shortens so much more than the lower rim, in order to make the upper gallery lighter and smaller, connect the under side of the upper rim at the fore side with the middle stool rail, with an airy raking curve; then the munions and gallery lights remain only to be represented to complete the quarters. And first draw the fore side of the lower gallery by a line set off on the sheer 14 feet 2 inches before, and parallel to the fore side of the quarter-piece, from the upper side of the lower rim to the under side of the middle stool rail, then set aft 12 inches on a square from this line, and draw another parallel thereto, and this will show the foremost munion of the lower gallery; then divide between the aft side of this munion and the fore side of the quarter-piece, into three lights, having a twelve-inch munion between each light, and then the light will be about 2 feet 11 inches, in the clear, on a square, then draw the bottom of each light about 6 inches above, and parallel to the lower rim, for the water-table, and their upper parts about 4 inches below the middle stool rail.

The lights of the upper gallery may next be drawn in a similar manner. Thus, draw the fore part as before, which is 11 feet 7 inches before the fore side of the quarter-piece, then set aft 10 inches on a square for the foremost munion and space between that and the fore side of the quarter pie

three munions of 10 inches broad each, and three lights about 2 feet 2 inches in the clear, draw the bottom of the lights about 5 inches above the upper rail, and the upper part of the lights about 5 inches below the under side of the upper [illegible] the quarters are complete. To finish the stern abaft, and above the upper counter, set abaft the middle stern timber on the upper side of the quarter deck, [illegible] inches, and draw a line upwards parallel to the aft side of the timber, and this line will be the projection of the balcony. On this line set down, below the under side of the quarter deck about $1\frac{1}{2}$ inch, from whence draw a curve that shall cut the side stern-timber at $1\frac{1}{2}$ inch below the under side of the quarter deck at that place, and to break in with the under side of the middle stool rail, at the aft side of the quarter piece, then draw another curve nearly parallel above it, from the upper side of the middle stool rail, to project 2 inches abaft the balcony, and it will represent the aft side view of the foot space rail, as far as the middle line. Draw an horizontal line at the upper side of the foot space rail abaft, then take the upper side of the middle rim above the middle stool-rail, and set it up in the same manner above the horizontal line last drawn, to cut the aft side of the balcony, and from thence draw a curve parallel to the foot-space rail, to the inside of the quarter piece, which is represented by a line drawn parallel to the aft side of the quarter-piece, at about 4 inches within it, then draw another curve parallel below the former, to the depth of the upper rim, and the breast rail of the balcony will be represented also. Then draw a parallel line 3 inches abaft the middle stern-timber from the under side of the foot space rail down to the upper counter rail, and that will draw the after munion at the middle of the stern.

Now draw in the taffrail and upper part of the quarter piece, which make a one view at the side. Set up 3 feet above the upper side of the round house, at the middle stern timber, and draw a line to the sheer, which will be the upper side of the taffrail, then draw a line 3 inches abaft the middle timber, and parallel to it, which will be the aft side of the taffrail [illegible] the side stern-timber [illegible] the [illegible] of the [illegible]

[illegible] complete.

The rudder now remains to be drawn in the sheer plan, which represents its breadth, and how it is attached to the stern-post. Set up from the upper edge of the keel [illegible] feet [illegible] inches for the lower hance, which is generally kept a little above the load water line, then set up [illegible] feet for the upper hance, then set aft, from the aft side of the stern-post, its breadth at the heel, which is 3 feet 8 inches, and at the lower hance [illegible] feet, then draw a line to these two breadths, and a parallel line 5 inches abaft it for the back, and the rudder is formed below the lower hance, except the heel, which at the foreside may come as low down as the middle of the main keel, and cut off with a line 4 inches short of that at the aft side, below which is fixed a sole, equal in depth to the false keel. This is to prevent its striking, if the ship touches the ground. Then draw a moulding at the lower hance, so as to reduce the breadth to [illegible] feet [illegible] inches. Then set aft 3 feet at the upper hance, and join the two last breadths by a straight line. Then reduce the upper hance, with an ogee moulding, to [illegible] [illegible]

the wing transom; then fix the under side of the lower brace about 8 inches above the upper side of the keel, then the others, which are five in number, may be placed at equal distances between the upper and lower brace, their lengths may be represented by setting off, before the aft side of the post, the length of the lower brace, which is 7 feet, and the second brace, which is 4 feet 6 inches, then, by drawing a line to these two, the intermediate ones will be governed by it; then set up the breadth of the straps, which is 4½ inches, drawing them parallel to the lengths above mentioned, and square from the aft side of the post. The pintles are next drawn, 4½ inches the breadth of their straps, immediately above the braces, and parallel thereto, across the rudder, and extend within 2 inches of the back. The pintles are 5½ inches in diameter, and 13 inches long, except the lower one, which is 15 inches long.

The steps of the side being mentioned, we will describe their situation. Before we can say the sheer draught is complete, the steps must be fixed to the side, at the fore part of the main drift, and in length what the distance between the ports will admit, they are generally placed 5 inches asunder, and 6 inches deep, and continued from 11 inches below the top of the side to the upper edge of the lower or main wales.

The chestree may be also drawn, which must be placed at a proper distance before the main-mast, for hauling home the main tack, therefore place it the most convenient abaft the break of the forecastle, which in this ship is 5 feet; it is sided 10 inches at the upper part or top of the side, and tapers to 6 inches at the lower part or upper edge of the channel wales.

Lastly, the anchor lining is a birthing of three-inch plank, projecting from a bolster on the side, at the upper edge of the channel wales, to the outside of the fore channel, and is to convey the peak of the anchor on to the plank sheer, to stow it clear of the side, and as it determines the length of the fore channel, it should always be drawn on the sheer plan by a radius equal to the length of the anchor from the ring to the peak of the fluke, allowing for the cat block at the outer end of the cat-head, and the lining should be so placed up the side, that the peak of the anchor may sweep up the middle of it. the fore side is finished agreeable to this sweep, and the aft side is shown perpendicular.

The cat-block may be likewise drawn abaft the main rail of the head, and the timber-head adjoining upon the plank sheer of the forecastle, and the sheer draught may be said to be completed.

Ships. Wilfully destroying a ship, with intent to prejudice the insurers; plundering a ship in distress, stealing goods of the value of 40s. from on ship-board, burning or destroying any of his Majesty's shipping or stores; are, by a variety of statutes, made felony, without benefit of clergy.

Ship money, an imposition charged on the ports, towns, cities, boroughs, and counties of this realm, in the time of Charles I., by writs, commonly called ship writs, under the great seal of England, in 1635 and 1636, for providing and furnishing certain ships for the King's service, &c. which was declared to be contrary to the laws and statutes of this realm, the petition of right, and liberty of the subject.

SHIRE, in geography, signifies the same as county; being originally derived from the Saxon ꞅcipan, to *divide*.

SHIVERS, or Sheevers, in the sea-language, names given to the little rollers or round wheels of pulleys.

SHOAD, among miners, denotes a train of metalline stones, serving to direct them in the discovery of mines.

SHOAL, in the sea-language, denotes a place where the water is shallow.

SHOE *for an anchor*, in a ship, the place for the anchor to rest, and fitted to receive the stock, &c. so as to prevent the sheets, tacks, and other running-rigging, from galling, or being entangled with the flukes.

SHOOTING. See Gunnery and Projectiles.

Shooting. See Sporting.

Shooting, maliciously, at persons in any dwelling house, or other place, though death should not ensue, is felony without clergy, by 9 George I. c. 22, commonly called the Black Act.

SHOPLIFTERS, those who steal goods privately out of shops. If the goods are of the value of 5*l.* though no person be in the shop, is felony without benefit of clergy. 10 and 11 William III. c. 23.

SHORE, a place washed by the sea, or by some large river. Count Marsigli divides the sea-shore into three portions; the first of which is that tract of land which the sea just reaches in storms and high tides, but which it never covers; the second part of the shore, is that which is covered in high tides and storms, but is dry at other times; and the third is the descent from this, which is always covered with water. The first part is only a continuation of the

Continent, and suffers no alteration from the neighbourhood of the sea, except that it is rendered fit for the growth of some plants, and wholly unfit for that of others, by the saline steams and impregnations; and it is scarcely to be conceived by any, but those who have observed it, how far on land the effects of the sea reach, so as to make the earth proper for plants, which will not grow without this influence; there being several plants frequently found on high hills, and dry places, at three, four, and more miles from the sea, which yet would not grow, unless in the neighbourhood of it, nor will ever be found elsewhere. The second part or portion of the shore is much more affected by the sea than the former, being frequently washed and beaten by it. Its productions are rendered salt by the water, and it is covered with sand, or with the fragments of shells in form of sand, and in some places with a tartarous matter deposited from the water; the colour of this whole extent of ground is usually dusky and dull, especially where there are rocks and stones, and these covered with a slimy matter. The third part of the shore is more affected by the sea than either of the others, and is covered with an uniform crust of the true nature of the bottom of the sea, except that plants and animals have their residence in it; and the decayed parts of these alter it a little.

SHORL, in mineralogy, occurs commonly in granite, gneiss, and other similar rocks; often in mass, but very frequently crystallised. The primitive form of its crystals is an obtuse rhomboid, the solid angle at the summit of which is 139°, having rhomboid faces, with angles of 114° 12′ and 65° 48′: but it usually occurs in three, six, eight, nine, or twelve sided prisms, terminated by four or five-sided summits, variously truncated.

SHORL, *black*. Colour black. Found in mass, disseminated and crystallized. Crystals three-sided prisms, having their lateral edges truncated. Sometimes terminating in a pyramid. It becomes electric by heat. When heated to redness, its colour becomes brownish red; and at 127° Wedgewood, it is converted into a brownish compact enamel. According to Wiegleb, it is composed of

Alumina	41.25
Silica	34.16
Iron	20.00
Manganese	5.41
	100.82

SHORL, *electric*. This stone was first made known in Europe by specimens brought from Ceylon; but it is now found frequently forming a part of the composition of mountains. It is sometimes in amorphous pieces, but much more frequently crystallized in three or nine-sided prisms, with four-sided summits. Colour usually green; sometimes brown, red, blue. Found in mass, in grains, and crystallized. Crystals three, six, or nine-sided prisms, variously truncated. Its texture is foliated. Specific gravity 3. Colour brown, sometimes with a tint of green, blue, red, or yellow. When heated to 200° Fahrenheit, it becomes electric, one of the summits negatively and the other positively. It reddens when heated, and is fusible *per se*, with white intumescence, into a white or grey enamel. According to Vanquelin, it is composed of

Silica	40
Alumina	39
Oxide of iron	12
Lime	4
Oxide of manganese	2.5
	97.5
Loss	2.5
	100

SHORLITE, a stone which received its name from M. Klaproth, is generally found in oblong masses, which, when regular, are six-sided prisms, inserted in granite. Its texture is foliated. Specific gravity 3.53. Colour greenish or yellowish white; sometimes sulphur yellow. Not altered by heat. It is composed of

Alumina	50
Silica	50
	100

SHORT-HAND, STENOGRAPHY. When mankind had acquired a tolerable degree of expertness and exactness in the use of letters by the ordinary modes of writing, it became the study of the curious to invent more concise methods of denoting the same words or phrases. Hence sundry schemes of abbreviation for compendious writing were devised; and the learned of different nations introduced them into their respective languages, according as more skill and greater perfection in writing them were acquired. Buxtorf has written a learned history of Hebrew abbreviations, as a key to understand the Rabbinical authors. Some of them are the incipient letters of several words, joined together as one, and marked

at the top with points; others are the final letters of words; and others, again, are contracted words, wherein two or three letters are made to denote an entire word. The Jews were particularly partial to these methods of abbreviation, to which they added a few arbitrary characters to express certain proper names, such as God, Jehovah, &c.

This kind of writing was, by degrees, introduced, and successfully practised among the Greeks. Nicolai gives it as his opinion that Xenophon first taught the Greeks to write by certain notes, in the nature of characters. Laertius confirms this opinion, and particularly mentions two methods of short writing, *viz.* one by contractions of words, and the other by arbitrary marks. This art was practised among the Romans at an early period. Indeed, the first invention of a system of short-hand, by which the writer was enabled to follow the most rapid speaker, has been ascribed by some to the poet Ennius, and it is said that it was afterwards improved by Tyro, Cicero's freed man; and still more so by Seneca. Ennius began the practice with one thousand one hundred marks of his own contrivance. As an elucidation of this subject, and to show in what estimation this art was held among the Romans, we may briefly notice two of the Roman Emperors, of very opposite characters; Caligula and Titus Vespasian. It was deemed a great defect in one of them to be ignorant of short-hand, and a perfection in the other, to be acquainted with this highly useful and ingenious art. Caligula was a man guilty of so many vices, that it might be imagined his ignorance of short-hand would not have fallen under the notice of an historian. And yet Suetonius mentions it as something remarkable, that he who was so expert in other matters, and wanted not capacity and parts, was totally ignorant of short-hand. Titus Vespasian, on the contrary, was remarkable for writing short-hand exceedingly swift. He was indeed a true lover of the art, and made it not only his business but his diversion. It afforded him great pleasure to get his amanuenses together, and entertain himself with trying which of them could write fastest; so that, by constant practice, he acquired such a command of hand, and such a facility in imitation, that he was wont to joke upon himself and say, what a special counterfeit he should have made.

The different schemes of short-hand formerly used, were probably much of the same nature, exceedingly *arbitrary*, and, for the most part, unintelligible to any but those who practised them; and, for that reason, were soon forgotten and destroyed. We may guess at the fate they generally experienced, by two books of short-hand mentioned by Trithemius. The first was a dictionary of short-hand, which he bought of an abbot, who was a doctor of law, for a few pence, to the great satisfaction of the community to which he belonged, who had ordered the short-hand marks to be erased, for the sake of the parchment on which they were written. The other was a short-hand copy of the book of Psalms, which he met with in another monastry, where the learned monks had inscribed upon it, by way of title, "A Psalter of the Armenia Language!" Several copies of a dictionary and psalter, in the Roman short-hand, are mentioned as extant in different libraries; but they are, in general, the same method, as may be judged by the accounts of those who mention them, and also from the appearance of the hand-writing of an old short-hand psalter, in the library of St. Germain's at Paris, a few pages from which were transcribed for the use of the writer of these observations.

Plutarch, in his life of Cato, informs us, that the celebrated speech of that patriot, relating to the Catilinian conspiracy, was taken and preserved in short-hand. There are numerous epigrams of Ausonius, Martial, and Manilius, descriptive and commendatory of short-hand. Probably the most ancient method of short-writing at present extant, is a Latin MS. entitled "Ars Scribendi Characteris;" or, "The Art of Writing in Characters." The author of this tract is unknown; but, we believe, it was printed about the year 1412.

The ancient Irish alphabets, particularly the first, which was purely stenographic, named Bobeloth, have a strong resemblance to many of our modern short-hands, but they are now little known. A specimen of this writing may be seen in Ledwich's Antiquities, p. 98.

M. Lambinet, in his Researches upon Printing, observes, that modern stenography, which, like the telegraph, dates in France from the foundation of the republic, has neither the inconvenience, nor the obscurity, nor the danger of the ancient. The old characters varied under the hand of the copiers, and the sense changed according to the genius of the interpreters; so that their contractions are become so

many enigmas, because we can refer to no other copies to ascertain the true reading, and because the authors are no longer in existence. "But," continues Lambinet, "by the present system of stenography, the writers follow the words of the public orators, take down their speeches, the motions, the debates of the tribune, or the lectures of the professors at the Lyceum, and produce a literal translation at last, in the usual characters, and in print." What the improved short hand is, to which this French writer alludes, we are not informed.

The ingenious attempt of the late learned Bishop Wilkins, towards a real character and philosophical language, has much the appearance of some short-hands now in use. How far this attempt might have been successful we know not, had the contrivance been carried to that degree of perfection of which the Bishop thought it capable. The reader may find a specimen of this philosophic character in Stowers' Printer's Grammar.

The shortest and most curious mode of writing, not professedly stenographic, which we have hitherto seen, is the specimen of ancient Webb, by the ingenious Mr. W. Owen. This also may be seen in Mr. Stowers' Grammar, p. 294.

The art of short-writing was first attempted to be published in this country in the year 1588, in a treatise entitled "Characterie, or the Art of Short, Swift, and Secret Writing, by Character, by Timothy Bright, M. D." Two years after the appearance of Dr. Bright's treatise, Mr. Peter Bale published his "Writing Schoolmaster," which he divided into three parts, the first of which he entitled "Brachygraphy," containing rules to write as fast as a man can speak, with propriety and dist nction. In 1618, appeared Willis's "Stenography, or Short-hand Writing, by spelling Characteries." This system consisted of ten alphabets, denominated words of sort; seven of which were composed of the initial letters of words, the rest, principally by the omission of unnecessary letters, and by symbolical figures. This system was attempted to be improved upon by Henry Dix's "Brachygraphy." Omitting the mention of numerous other methods of Short-hand writing, that soon followed these several schemes, we must proceed to lay before the reader such a system of stenography, as, if generally known, would supersede the necessity of every other system, having been the result of great labour and ingenuity, as well as recommended, and its practical utility sufficiently demonstrated, by the practice of some of the first literary characters of our age, and the best judges of the art. This system is that invented by the late ingenious and worthy Mr. John Byrom, M. A. F. R. S. commonly known by the appellation of Doctor, availing ourselves, at the same time, of the very judicious improvements introduced by Mr. Molineux, of Macclesfield, whose Introduction to Byrom's Short-hand is certainly the most beautiful and complete work on the subject ever yet produced to the public. It is published, for the author, by Longman and Co. London.

The short-hand alphabet, as exhibited in the annexed plate, consists of the shortest and simplest marks in nature and on the proper formation and combination of these characters, depend the beauty and accuracy of the writing. We will endeavour to lay down such directions, as appear necessary to acquire a general knowledge of the art; referring our readers to Mr. Molineux's Treatise, for more ample instructions on the subject.

The great end of short-writing being to convey the sounds of words, by the fewest, as well as the most simple characters, all those letters which are not distinctly sounded in pronunciation are to be omitted; except in a few cases, where either the word would be rendered ambiguous, or present an unsightly appearance, without certain of its quiescent letters; for instance, it is evident that the letters *w a k d*, properly joined together, might be allowed to represent *walked*, provided the reader could always remember to sound the *a* broad, as in *wall*, but as the word, so contracted, might easily be mistaken for the word *waked*; it is always best to spell it with the letter *l*; thus, *walkd*. This example will suffice for other words of the like nature. The omission of vowels, especially in the middle of words, has been a fault too common with writers on the present subject yet it must generally be observed, that in short-writing it is proper to insert those vowels only which are absolutely necessary in the pronunciation, which is a great saving of time, as well as conducive to the beauty of the writing. It is sometimes convenient, for the sake of facility in joining, to substitute one letter for another. as *k* for *q*, *ks* for *x*, &c. yet this should never be resorted to, but for some obvious advantage of beauty or brevity.

The short-hand alphabet, as some suppose concerning the Hebrew, consists of consonants only, the vowels being supplied by dots differently placed. These consonants, running neatly into each other, will form the marks for words, never lifting the pen in writing a word, except in a very few instances, and for the sake of preserving the beauty of the writing, which will always be attended with a correspondent degree of brevity and legibility, a circumstance, perhaps, peculiar to the method of Mr Byrom, where beauty, brevity, and legibility are happily combined.

The twenty-one consonants which compose the short-hand alphabet, are formed out of simple lines, to some of which are attached small loops or twirls. These lines derive their respective powers and properties by their difference of position, and by some of them being made curvilineal.

The horizontal characters are always to be written from left to right; the perpendicular ones are invariably written downwards, and with respect to the oblique characters, it is to be observed, that those which lean to the left are generally written upwards, while those having their inclination to the right hand, are always written downwards. Not any of the twirled letters (the duplicate characters denoting *h*, *j*, *w*, and *sh*, which are never joined to any other letters; but simply stand for the words *had*, *just*, *would*, and *should*, excepted) ought never to be written so as to end with the loop. This observation must not be forgotten by the learner, and he will never be at a loss about the manner of joining the looped characters to other letters.

It will be observed that some of the letters are denoted by two, and the letter *l* even by three different characters, but as these characters are formed in the same manner, having only a simple change of position, and as they will be found to be of singular advantage in the joining of them to some letters, no ambiguity can possibly arise by their occasional use. The little mark, denoting the abbreviation for the two Latin words *et cœtera*, is formed out of the letters *t* and *s*, and is well calculated for the purpose to which it is applied. It is the only character (if we except the little mark for the very common termination o *ing*) which has the appearance of an arbitrary mark in the whole system; and even this is formed not strictly upon an arbitrary, but an alphabetical principle.

We have already observed that the vowels are expressed in short-hand by means of dots, distinguished by their relative situations with respect to the consonants to which they are supposed to be joined. Although it is proper, in the spelling of words, to use no more vowels than are strictly necessary to convey the sound; yet as all writing must be rendered extremely illegible by their total omission in the middle of words, we will here lay down proper directions for their use and application. Whenever a vowel constitutes a perfect syllable in any word, whether that syllable be incipient, radical, or terminative, it must always be inserted, unless in the case of following a very rapid speaker; and the vowels which are then unavoidably omitted, should be inserted as soon as convenient afterwards, while the subject is fresh in the writer's memory, by which means the legibility of the writing will be effectually secured and preserved.

The manner of placing the vowels in this system is, of all others, the most natural, and the freest from ambiguity. A simple stroke, however placed, will naturally suggest the idea of supplying five different places for the five vowel points: *viz.* the top, the middle, the bottom, and the centres of the halves when so divided. Care, however, must be taken not to place the dot for the vowel *a*, *over* the perpendicular or oblique characters; nor the same vowel point *before* the horizontal ones. By a very slight attention, it will be observed that in this plan of short-writing the same general method is to be observed as in common writing, *i.e.* not to write perpendicular letters from the bottom upwards, nor any letters from the right to the left; consequently all the vowel points belonging to upright consonants are to be placed immediately *before* or *after* the consonant, as the case may require; those connected with the horizontal characters, exactly *over*, when they precede, and *under*, when they follow the consonant.

The vowels are always reckoned from the beginning of the consonant. When, therefore, any inclined consonant is begun at the bottom of the short-hand line, and written upwards, the vowels are always counted from the bottom, on each side of the character, upwards. A due attention to the manner of placing the vowel points, in the cases of curved or semi-circular letters, as it is exhibited in the annexed plate, will explain the matter beyond the possibility of misconception or embarrassment.

With respect to the long and short sounds of vowels, it is convenient, when time will allow of it, to express the broad sound of a vowel by making its representative dot a little larger than in the usual method of expressing the vowels. When two, or more, different vowels occur, without any intervening consonant, they may be distinguished by making the first a little thicker and stronger, diminishing their respective strengths until the last vowel is expressed, by being made of the usual thickness. Two *e*s, or two *o*s, may be expressed by two dots of the same size. In swift writing, we know, these minutiæ cannot always be strictly attended to. It is, nevertheless, convenient to have a method so simple and useful to resort to, when time will allow, and it is one of the many excellencies peculiar to this system, that it will admit of these orthographical attentions.

The letter *y*, at the beginning of words, is a consonant, but at the end of words, or when it follows a consonant, it is a vowel, and, as such, is represented, in short-hand, by a dot in the *i*'s place, as in the word *buti*, *beauty*.

As the horizontal characters may be written at the top, or middle, or bottom, of the line, the vowel may be sometimes *indicated* by their situation between the parallels, as *same*, at the top; *sin*, in the middle, and *sun*, at the bottom of the line.

There are few monosyllables, beginning with a vowel, that are immediately followed with either *h* or *w*, for which reason the following rule, peculiar to these two letters, will seldom occasion any ambiguity, and affords a convenient method of expressing a great variety of very common words. The letters *h* and *w*, having a vowel point before them, are to be considered as denoting, by one mark, the two letters, *ht*, *wt*, respectively, with the prefixed vowel between them, as in the words *hat*, *hit*, *hot*, *hut*; *wat*, *wet*, *wit*, *wot*, &c.

Having said thus much concerning the nature and use of the vowel points, we will proceed to give some further directions relative to the form and proportion of the short hand characters, the various ways of joining the curvilineal ones with the greatest ease and elegance, together with some rules, designed to obviate a few apparent difficulties, which may be supposed to occur, more or less, to every learner of short-hand.

1. All the perpendicular and inclined letters are made to touch, as it were two imaginary parallel lines, whose distance is supposed to be adjusted by the length of the short-hand *t*, | It is sometimes necessary, in order to preserve a perfect lineality in the writing, to make these letters only half their usual size, as in the words *foot*, *form*, *gold*, &c. In a very few instances, where lineality cannot be preserved, even by thus curtailing the size of the letters, it is always best to lift the pen, and write the word at twice, taking care to place the detached parts very near to each other, to denote their connection. Instances of this kind occur so very seldom in practice, that no perceptible difference will be experienced in the brevity of writing, while a very material advantage will be gained on the score of beauty and legibility; considerations never to be lost sight of by the lovers of useful and rational stenography.

2. The diameter of the horizontal semicircular letters is the short-hand — *s*; and their height is rather more than one-third part of the letter | *t*.

3. As both the *beauty* and the *brevity* of short-hand writing depend very much on avoiding, as much as possible, the making of angles, and on the general uniformity of the writing, it is proper in joining such letters as *m* and *n*, *m* and *f*, *m* and *p*, &c. together, to deviate a little from the correct form of each letter; so that they may readily and naturally run into each other. The learner will easily discern where it is necessary to preserve the precise point of concurrence, as in the case of *md*, *hb*, &c.

4. The letter | *t* is occasionally used for *th*, writing the adjoining letter only half its usual size; as in *thr*, *thm*, &c.

5. Except in the foregoing case, a letter of half size, when it is made *optionally*, always indicates that the adjoining character is to be resolved into two letters. When it is requisite to double the letters *r* or *f*, and no consonant is required to be joined with them, they are generally lengthened by a greater inclination of the stroke than usual. Double *t*, and double *s*, when necessary, may be made by a little break in the middle, which may be done, without taking off the pen, by only a very slight movement of it from the line it was describing. There are one or two cases where it is better entirely to lift the pen, and make a small stroke through the letter, nearly in the manner we usually cross the *t* in long hand.

This expedient is requisite in writing the words *idler*, *butler*, *miller*, &c.

6. No letters are to be doubled in short-hand, unless some vowel comes between them.

7. When there are various ways of joining the same letters together, which, in the present highly improved system of short-hand, is not unfrequently the case, the learner should accustom himself to that which is the best, or most lineal, preserving as much as possible the full proportion and compact form of every letter.

It is to be observed, as another advantage peculiar to this system, that here the strictest adherence to the common rules of punctuation may be observed. The period, or full stop, which is supplied by a very small circle, ∘ being the only exception.

The characters denoting the prepositions and terminations being derived from the alphabet, are easily retained in the memory, and are of very extensive use to the brevity and legibility of short-hand. Their respective powers and uses are distinctly delineated in the plate. It is sufficient to remark, that in writing them, they ought always to be formed rather smaller than the rest of the letters, and should be placed sufficiently near the radical part of the word of which they constitute a part, that they may not be mistaken for separate and distinct words. Double prepositional characters joined together, as *compre-*, *misunder-*, &c.

The plural of nouns, ending in *s*, ought to have their terminative letter written rather smaller than the other letters. A very little practice will accustom the writer to this method of denoting such plural nouns.

When the learner has acquired a perfect knowledge of so much of the art as we have already laid down, he may proceed to make himself acquainted with the following

Rules of Abbreviation; by which he will be enabled to follow the most rapid speaker, and will soon become an expert stenographer.

1. The auxiliary verbs, the participle *not*, and the pronouns, being severally denoted by their first consonant, may be joined to one another; as , *can be*, , *will be*, , *have not been*.

2. Join the marks or letters in an unusual manner, in order to show that each particular mark denotes a word, and not a single letter; as, by joining the letter *n* to the middle instead of the top of the letter *t*, the whole character , will represent the words *in the*; so, also, the letter *s*, joined to the letter *t*, and drawn from the middle of the preceding consonant, thus , will denote the two words *it is*, or , *it was*. This rule is very comprehensive. The writer will apply it as he finds it necessary or convenient so to do.

3. Derivative nouns, adjectives, and adverbs, may be very conveniently expressed by points, differently placed, at the end of their last consonant. The substantive point being placed immediately following the consonant, and in a direct line with it; the adjective to have its point placed also a little lower down to the left of the substantive point; and the adverb point to be placed, in the same manner, to the right of the substantive point; as, , *forgetfulness*; , *forgetful*; , *forgetfully*.

4. Very common words, or such as have an immediate relation to the subject, and are therefore easily discoverable, may be denoted by their first consonant, or first vowel and consonant, with the substantive, adjective, or adverb point annexed. The adjectives, which usually accompany such substantives, may also be denoted by their first consonant, joined to the substantive; as, , *humble servant*; , *human nature*; , *christian religion*, &c.

5. Place a dot at the point of concurrence of two consonant marks, to denote two substantives connected together by some preposition, which is omitted; as, , *love of God*, or *light of the gospel*; , *cause of gravity*, &c. Also when an adjective precedes either of the substantives, they may all three be represented by their first consonants joined together, with the dot placed at the end of the first substantive; as the , *great goodness of God*.

6. The substantive point, placed before a single consonant mark, denotes that the substantive is to be repeated, with some intervening preposition; as, , *day after day*; , from *time to time*, &c.

7. Place the substantive, adjective, or adverb point before two or more consonant marks, to denote two or more substantives, adjectives or adverbs connected by a con-

junction; as, , *King*, *Lord*, and *Commons*; , *soberly*, *righteously*, and *godly*, &c.

8. Express long words by their first syllables, with as many points annexed as there are syllables wanting. In very common words the points may be occasionally omitted.

9. Express long words by their prepositions, together with their next vowel or consonant only.

10. Words may be denoted by their first vowel and consonant, with their terminations added; as, , *arbitrary*; , *opportunity*, &c.

11. Words easily discovered by their connection, may be expressed by their first vowel and consonant, or by their prepositions only; and as few English words end with the syllable *to*, the preposition *to* may be joined to the preceding word; as, , *belongs to*; , *satisfactory to*, &c.

12. Join the pronouns to prepositions; as, , *to me*; , *to us*; , *to you*, &c. always adding the vowel point, when the words would otherwise be liable to be mistaken.

13. Join the preceding word, the preposition, and pronoun all together; as, , *belongs to me*; , *agreed with me*, &c.

14. Join adverbs, verbs, prepositions, pronominal adjectives, and substantives all together; as, , *safely depend upon my word*, &c.

15. Many common phrases, formed by a substantive, preceded by the prepositions *with*, *without*, *in*, &c. and followed by *to*, *of*, &c. may be abbreviated; as, , *with regard to*; , *in consequence of*, &c. These several words are expressed by their first consonants only, joined together, the vowel *o* being added in the first example to denote the preposition *to*.

16. In like manner, denote common adverbial phrases by the initial consonants joined together; as, , *in like manner*; , *in particular*; , *in a great measure*, &c.

17. Numerous contractions may be made when *it is*, or *it was*, are followed by an adjective, and *to*, or *that*; as, , *it is impossible to*; , *it is not to be supposed that*, &c.

The above abbreviating rules, though few in number, are very extensive in their application. An assiduous attention to the nature and idiom of our language may suggest others as useful and extensive as these. Proper care being taken to lay a right foundation, the legitimate ways of contracting will increase in proportion to the writer's want of them. It must be obvious to every one how much a systematic plan of abbreviation, like this, is superior to that which consists of a multitude of arbitrary marks to signify particular words and phrases; a plan which not only disfigures the writing, but renders it nearly, if not entirely, illegible even to the writer himself, unless it is transcribed into long hand while the subject is fresh in his memory. The experience of the late ingenious Dr. Darwin will serve to illustrate the futility of these systems. "The book I learned short-hand from," says this elegant writer, "was published by Gurney, and said to be an improvement on Mason; other treatises of short-hand I have also examined, and found them all of nearly equal excellence. I can only add, that many volumes I wrote from medical lectures I now find difficult to decipher." Had Dr. Darwin practised the system of Mr. Byrom, we can assert, both from our own experience, and the experience of many others, that he would have found no serious difficulty in deciphering his medical lectures at any period of time after they were written. For, as the present indefatigable Dr. Mavor observes, in the introduction to his own treatise on stenography, "it must be owned that it is above the reach of human ingenuity to exceed his (Mr. Byrom's) general plan, which must for ever be the basis of every future rational system."

The first Part of the Specimens without Contractions, spelt according to the Method used in writing Short-hand. (See Plates Short-hand.)

THE BEAR. A FABLE.

A bear, wo ws bred in the savg desrts of Sibria, had an inklnation to see the wrld. He travld frm forst to forst, and frm on kngdm to anthr, making mni prfnd obsrvations in hs wa. Among the rst of hs exkrsns, he km bi aksdnt into a farmr's yard,

wr he saw a nmbr of pltri stnding to drnk bi the sid of a pool. Obsrving that at evri sip they turnd up thr heds tords the ski, he could nt frber enkring the resn of so pekulr a srmni. They told hm that it ws bi wy of rtrning thanks to hvn fr the bnfts they rsvd, and ws indd an ansnt and rlgs kstm, which they could nt, wth a saf knsns, or wthot impiity, omit. Her the bear brst into a ft of laftr, at ons mimking thr gestrs, and rdkling thr superstition, in the mst kntmtos mnr. On this the kok, wth a sprt sutable to the bldness of hs krktr, adrsd hm in the foloing wrds. "As you ar a strngr, sr, you prps ma be exksd the indansi of this behvr; yet gvme leav to tl you, that non but a bear would rdkl ani rlgs srmni watsoever, in the prsns of thos wo bliev thm of imprtns."

An Exemplification of the Specimen with Contractions; containing numerical References to all the Rules of Abbreviation, the fourteenth, fifteenth, and seventeenth excepted.

A bear, who was bred IN THE[2] savage
A ber, wo ws bred nt sug

deserts of Siberia, had an INCLINATION[4] to
dsrts of Sbrie, had an in. to

see the WORLD[4]. He travelled from
see the W. He trvld frm

FOREST TO FOREST[6], and from one
f. and frm on

KINGDOM[3] to another, making many
kng. to anthr, mking mni

profound OBSERVATIONS[11] IN HIS[12] way.
prfnd obs nis wa.

Among the rest OF HIS[12] EXCURSIONS[9], he
Among the rst fis exk. he

came by ACCIDENT[4] into a farmer's yard,
km bi ak. into a frmr's yrd,

where he saw a number of poultry standing
wr he saw a nmbr of pltri stnding

to drink by the SIDE OF A POOL.[5] Observing,
to drnk bi the sp Obsrving,

that at every sip they turned up their
that at evri sp they trnd up thr

HEADS[4] towards the sky, HE COULD NOT[1]
hs. trds the ski, hkn

forbear enquiring the reason of so peculiar
frbr enqring the rsn of so pklr

a ceremony. They told him, that IT WAS[2]
a srmni. They tld hm, that ts

by way of returning thanks to HEAVEN[4] for
bi way of rtrning thnks to H. fr

the benefits they received, and was indeed
the bnfts they rsvd, and ws indd

an ANCIENT AND RELIGIOUS[7] custom, which
an nr kstm, which

they could not, with a safe conscience, or
they could nt, wth a saf knsns, or

without IMPIETY[10], omit. Here the bear
wtht imity, mit. Hr the ber

burst into a FIT OF LAUGHTER[5], at once
brst into a ft at ons

mimicking their gestures, and ridiculing
mmking thr gstrs, and rdkling

their SUPERSTITION[9] IN THE[2] most
thr superst. nt mst

CONTEMPTUOUS MANNER[4]. ON THIS[12], the
cm. onis, the

cock, with a spirit SUITABLE TO[11] the
kk, wth a sprt ste the

BOLDNESS OF HIS[13] character, addressed
bfis krktr, adrsd

him IN THE[2] FOLLOWING[10] words. 'As you
hm nt foing wrds. 'As you

are a stranger, sir, you PERHAPS[3] MAY BE[1]
ar a strngr, sr, you p. mb

excused the INDECENCY[4] OF THIS[12]
xksd the ind. fis

BEHAVIOUR[9]; yet GIVE ME LEAVE TO[16] tell
beh. yt gmlto tl

you, that none but a bear would ridicule
you, that nn but a ber would rdkl

any RELIGIOUS CEREMONY[4] whatsoever,
ani rs. watsoever,

IN THE[2] presence OF THOSE[12] who believe
nt prsns foe wo blv

them of importance.'
thm of imprtns.'

The learner will perceive, by this exemplification of the short specimen on the Plate, that the rules of abbreviation are not only constructed on the most simple and scientific principles; but that they possess an almost unlimited power of contraction, and have a peculiar adaptation to the genius and phraseology of our language. With these rules, perfectly learnt, and brought into use by experience, the present system

of short-hand may be applied to all the purposes for which this invaluable art is intended, with as little labour in the acquisition, and with less ambiguity in decyphering, than attends the learning of any other system of stenography hitherto made public.

Having availed ourselves of the improvements made by Mr. Molineux on this mode of short-writing, first invented by Mr. Byrom, and recommending the learner for further instructions to Mr. Molineux's treatise, we think it only necessary, in order to give the learner a still more adequate knowledge of this system of short-hand, to lay before him the following

GENERAL DIRECTIONS FOR A YOUNG STENOGRAPHER.

1. Short-hand is one of the perpendicular hands, and that your writing may have a vertical appearance, always place yourself exactly parallel with your paper.

2. Make all your strokes of an equal thickness; and endeavour to be as correct as possible in the formation of the Short-hand characters; because any material deviation, either in their shape, or in the position of the stroke, may express a different letter, or produce illegibility.

3. Let the looped or twirled letters have their loops made as circular as is consistent with beauty and ease of joining.

4. Make the horizontal characters which denote the letters *m* and *n*, with their derivatives, *ch* and *g*, nearly semicircular; but the rest of the curvilineal letters, which are either vertical or oblique, are always less curved, except when they are made only half size.

5. Spell in the shortest, but neatest and most compact manner possible.

6. Use no more vowels than are necessary; yet never leave out any that are distinctly sounded.

7. Observe lineality and beauty at all times, and occasionally lift your pen, rather than fall below or rise above the space allotted for the Short-hand characters.

8. Use no arbitrary marks at all; but let every abbreviation be formed upon rational and scientific principles.

9. Never use the common stops or points for any but their own proper and legitimate purpose.

10. Never affect too much brevity: common Short-hand is short enough for all common purposes.

11. Make no fanciful innovations in the art: but let all your improvements be founded on the rational principles laid down by the ingenious Inventor.

12. If you write Byrom's Short-hand, your writing will be easily read by all who practise the same system. Let all rational Stenographers observe uniformity, and the Art will soon become generally useful.

13. Write not too close; and never suffer your characters to have a weak, diminutive appearance. Let your whole practice be bold and dignified; agreeably to the genius of the system you have adopted.

14. Do not make a secret of the Art: it is worthy of being universally known and practised.

SHORT *sightedness*, in medicine. See MYOPIA.

SHOT, a denomination given to all sorts of balls for fire arms; those for cannon being of iron, and those for guns, pistols, &c. of lead.

"To find the weight of an iron shot" whose diameter is given; and the contrary. Rule. Double the cube of the diameter in inches, and multiply it by 7; so will the product (rejecting the two last or right hand figures) be the weight in pounds. Ex. What is the weight of an iron shot of 7 inches diameter. The cube of 7 is 343, which doubled is 686, and this multiplied by 7 produces 4802, which, with the right-hand figures rejected, gives 48 pounds, the weight required.

"To find the diameter of the shot," when the weight is given. Rule. Multiply the cube root of the weight in pounds by 1.923, and the product is the diameter in inches. Ex. What is the diameter of an iron shot of 52 pounds? The cube root of 52 is 3.732, which multiplied by 1.923 gives 7.177 inches, the diameter required.

Rule by Logarithms.

To one-third of the logarithm of 52	0.572001
Add the constant logarithm	0.283979
And the sum is the logarithm of the diameter 7.177	0.855980

"To find the diameter of a shot," from the impression or cavity it makes by striking a brass gun, or other object. Rule. Divide the square of the radius of the cavity by the depth of it, and add the quotient to the depth, the sum will be the diameter of the shot required.

SHOT, *common, small*, or that used for fowling, should be well sized: for, should it be too great, then it flies thin and scatters

too much: or if too small, then it has not weight and strength to penetrate far, and the bird is apt to fly away with it. In order, therefore, to have it suitable to the occasion, it not being always to be had in every place fit for the purpose, we shall set down the true method of making all sorts and sizes under the name of mould-shot, formerly made after the following process:

Take any quantity of lead you think fit, and melt it down in an iron vessel; and as it melts keep it stirring with an iron ladle, skimming off all impurities whatsoever that may arise at top; when it begins to look of a greenish colour, strew on it as much auripigmentum, or yellow orpiment, finely powdered, as will lie on a shilling, to every twelve or fourteen pounds of lead; then stirring them together, the orpiment will flame. The ladle should have a notch on one side of the brim, for more easily pouring out the lead: the ladle must remain in the melted lead, that its heat may be the same with that of the lead, to prevent inconveniences which otherwise might happen by its being either too hot or too cold; then, to try your lead, drop a little of it into water, and if the drops prove round, then the lead is of a proper heat; if otherwise, and the shot have tails, then add more orpiment to increase the heat, till it is found sufficient.

Then take a plate of copper, about the size of a trencher, which must be made with a hollowness in the middle, about three inches compass, within which must be bored about 40 holes according to the size of the shot which you intend to cast: the hollow bottom should be thin; but the thicker the brim, the better it will retain the heat. Place this plate on a frame of iron, over a tube or vessel of water, about four inches from the water, and spread burning coals on the plate, to keep the lead melted upon it; then take some lead and pour it gently on the coals on the plate, and it will make its way through the holes into the water, and form itself into shot; do thus till all your lead is run through the holes of the plate, taking care, by keeping your coals alive, that the lead does not cool, and so stop up the holes.

While you are casting in this manner, another person with another ladle may catch some of the shot, placing the ladle four or five inches underneath the plate in the water, by which means you will see if they are defective, and rectify them. Your chief care is to keep the lead in a just degree of heat, that it shall be not so cold as to stop up the holes in your plate, nor so hot as to cause the shot to crack; to remedy the heat, you must refrain working till it is of a proper coolness; and to remedy the coolness of your lead and plate, you must blow your fire; observing, that the cooler your lead is, the larger will be your shot; as, the hotter it is, the smaller they will be.

After you have done casting, take them out of the water, and dry them over the fire with a gentle heat, stirring them continually that they do not melt; when dry, you are to separate the great shot from the small, by the help of a sieve made for that purpose, according to their several sizes. But those who would have very large shot, make the lead trickle with a stick out of the ladle into the water, without the plate. If it stops on the plate, and yet the plate is not too cool, give but the plate a little knock, and it will run again; care must be had that none of your implements are greasy, oily, or the like; and when the shot, being separated, are found too large or too small for your purpose, or otherwise imperfect, they will serve again at the next operation.

Shot, *patent milled*, are thus made; sheets of lead, whose thickness corresponds with the size of the shot required, are cut into small pieces, or cubes, of the form of a die. A great quantity of these little cubes are put into a large hollow iron cylinder, which is mounted horizontally and turned by a winch; when by their friction against one another, and against the sides of the cylinder, they are rendered perfectly round and very smooth. The other patent-shot are cast in moulds, in the same way as bullets are.

SHRIMP, in ichthyology, the English name of two different species of the squilla, viz. the common shrimp, and the smooth-nosed shrimp. See Squilla.

SHROWDS, or Shrouds, in a ship, are the great ropes which come down both sides of the masts, and are fastened below to the chains on the ship's side, and abaft to the top of the mast; being parcelled and served, in order to prevent the mast's galling them. The top mast-shrowds are fastened to the puttock-plates, by dead eyes and lauiards, as the others are. Some of the terms relating to the shrowds are; ease the shrowds; that is, slacken them; and, set up the shrowds; that is, set them stiffer.

SHUTTLE, in the manufactures, an instrument much used by weavers, in the

middle of which is an eye, or cavity, wherein is inclosed the spoul with the woof. See WEAVING.

SIBBALDIA, in botany, so named in memory of Sir Robert Sibbald, professor of physic at Edinburgh, a genus of the Pentandria Pentagynia class and order. Natural order of Senticosæ. Rosaceæ, Jussieu. Essential character: calyx ten cleft; petals five, inserted into the calyx; styles from the side of the germ; seeds five. There are three species.

SIBTHORPIA, in botany, so named in honour of Humphrey Sibthorp, M. D. professor of botany at Oxford, a genus of the Didynamia Angiospermia class and order. Natural order of Pediculares, Jussieu. Essential character: calyx five-parted; corolla five-parted, equal; stamina in remote pairs; capsule compressed, orbicular; two celled, with the partition transverse. There is only one species, *viz.* S. Europœa, Cornish money-wort, a native of Portugal and England, in shady places; it flowers in July and August.

SICE *ace*, a game with dice and tables, whereat five may play; each having six men, and the last out losing. At this game, they load one another with aces; sixes bear away; and doublets drinks, and throws again.

SICYOS, in botany, a genus of the Monoecia Syngenesia class and order. Natural order of Cucurbitaceæ. Essential character: calyx five-toothed; corolla five-parted: male, filaments three: female, style trifid; drupe one-seeded. There are three species.

SIDA, in botany, a genus of the Monadelphia Polyandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Generic character: calyx perianth one-leafed, angular; corolla, petals five, wider above, emarginate, fastened below to the tube of the stamens; stamina, filaments very-many, united below into a tube, in the apex of the tooth, divided; pericarpium, capsule roundish, angular, composed of five or more cells; seeds solitary. There are ninety-nine species, natives of warm climates; and most of them are found in the East or West Indies. The Chinese make cords of the S. abutilon. This plant loves water, and may be advantageously planted in marshes and ditches, where nothing else will grow. The maceration of the smaller stalks is finished in about fifteen days; of the larger in a month. The strength and goodness of the thread appears to be in proportion to the perfection of the vegetation, and to the distance that the plant is kept at from other plants. The fibres lie in strata, of which there are sometimes six; they are not quite straight, but preserve an undulating direction, so as to form a net-work in their natural positions. Their smell resembles that of hemp; the fibres are whiter, but more dry and harsh, than those of hemp. The harshness is owing to a greenish gluten which connects the fibres; and the white colour must always be obtained at the expense of having this kind of thread less supple; when of its natural hue, it is very soft and flexible.

SIDE, the half of any thing, as an animal, a ship, &c. The sides of an animal are distinguished into the right and left side; but those of a ship, into the starboard and larboard side. In geometry, the sides of a rectilinear figure are the lines which form its periphery.

SIDES *men*, or SYNOD'S *men*, persons who, in large parishes, are appointed to assist the churchwardens, in their inquiry and presentments of such offenders to the ordinary, as are punishable in the spiritual court.

SIDEREAL *day*, is the time in which any star appears to revolve from the meridian to the meridian again; which is 23 hours 56′ 4″ 6‴ of mean solar time; there being 366 sidereal days in a year, or in the time of 365 diurnal revolutions of the Sun; that is, exactly, if the equinoctial points were at rest in the heavens. But the equinoctial points go backward, with respect to the stars, at the rate of 50″ of a degree in a Julian year; which causes the stars to have an apparent progressive motion eastward 50″ in that time. And as the Sun's mean motion in the ecliptic is only 11 signs 29° 45′ 40″ 15‴ in 365 days, it follows, that at the end of that time he will be 14′ 19″ 45‴ short of that point of the ecliptic from which he set out at the beginning; and the stars will be advanced 50″ of a degree with respect to that point. Consequently, if the Sun's centre be on the meridian with any star on any given day of the year, that star will be 14′ 19″ 45‴ + 50″ or 15′ 9″ 45‴ east of the Sun's centre, on the 365th day afterward, when the Sun's centre is on the meridian; and therefore that star will not come to the meridian on that day till the Sun's centre has passed it by 1′ 0″ 38‴ 57⁗ of mean solar time; for the Sun takes so much time to go through an arc of 15′ 9″ 45‴;

and then, in 365^d 0^h 1′ 0″ 38‴ 57⁗ the star will have just completed its 366th revolution to the meridian.

SIDERITE, a name given by Bergman to a supposed peculiar metallic substance, which is the principal cause of the brittleness of some kinds of bar iron. This has long since been discovered as the phosphate of iron.

SIDERITIS, in botany, *iron-wort*, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: calyx five-cleft; corolla ringent; upper lip bifid, lower three-parted; stamina within the tube of the corolla; stigma, the shorter involving the other. There are twenty species.

SIDEROXYLON, in botany, *iron-wood*, a genus of the Pentandria Monogynia class and order. Natural order of Dumosæ. Sapotæ, Jussieu. Essential character: corolla five-cleft; nectary five-leaved; stigma simple; berry five-seeded. There are nine species, chiefly natives of the Cape of Good Hope.

SIEGE, in the art of war, the encampment of an army before a fortified place, with a design to take it. The method of encamping is very different in a siege, from that observed on a march; as in the former the army environs the place, without cannon shot, that nothing may enter. If the place be situated on a river, a detachment is sent to the other side, and bridges of communication made, both above and below the town. The army also encamp with their backs to the town, with the battalions and squadrons interlined; and having taken possession of all the heights, whence the enemy may be annoyed, the engineers trace the lines of circumvallation and contravallation; every regiment working at the place appointed them. See FORTIFICATION. Captain James, in his Military Dictionary, has given the following rules, which ought to be adopted in sieges. The approaches should be made without being seen from the town, either directly, obliquely, or in the flank. No more works should be made than are necessary for approaching the place without being seen; *i. e.* the besiegers should carry on their approaches the shortest way possible, consistent with being covered against the enemy's fire. All the parts of the trenches should mutually support each other; and those which are furthest advanced, should be distant from those that defend them above 120 or 130 toises, that is, within musket-shot. The parallels, or places of arms the most distant from the town, should have a greater extent than those which are the nearest, that the besiegers may be able to take the enemy in flank, should he resolve to attack the nearest parallels. The trench should be opened or begun as near as possible to the place, without exposing the troops too much, in order to accelerate and diminish the operations of the siege. Care should be taken to join the attacks; that is, they should have communications, to the end that they may be able to support each other. Never to advance a work, unless it be well supported; and for this reason, in the interval between the second and third place of arms, the besiegers should make, on both sides of the trenches, smaller places of arms, extending 40 or 50 toises in length, parallel to the others, and constructed in the same manner, which will serve to lodge the soldiers in, who are to protect the works designed to reach the third place of arms. Take care to place the batteries of cannon in the continuation of the faces of the parts attacked, in order to silence their fire; and to the end that the approaches, being protected, may advance with great safety and expedition. For this reason the besiegers shall always embrace the whole front attacked, in order to have as much space as is requisite to place the batteries on the produced faces of the works attacked. Do not begin the attack with works that lie close to one another, or with rentrant angles, which would expose the attack to the cross fire of the enemy.

"Stores required for a month's siege are as follow:" powder, as the garrison is more or less strong, 8 or 900,000*lb.*; shot for battering pieces, 6,000; shot of a lesser sort, 20,000; battering cannon, 80; cannons of a lesser sort, 40; small field-pieces for defending the lines, 20; mortars for throwing shells, 24; mortars for throwing stones, 12; shells for mortars, 15 or 16,000; hand-grenades, 40,000; leaden bullets, 180,000; matches in braces, 10,000; flints for muskets, best sort, 100,000; platforms complete for guns, 100; platforms for mortars, 60; spare carriages for guns, 60; spare mortar-beds, 60; spare spunges, rammers, and ladles, in sets, 20; tools to work in trenches, 40,000.

Several hand-jacks, gins, sling-carts, travelling forges, and other engines proper to raise and carry heavy burdens; spare timber, and all sorts of miner's tools, mantlets, stuffed gabions, fascines, pickets, and gabions.

SIENITE, in mineralogy, one of the compound primitive rocks that consists essentially of crystals and grains of hornblend imbedded in felspar. Quartz and mica are occasionally found in sienite, but in very small quantity. It is commonly in mass, and is rarely either schistose or stratified. It sometimes contains metallic veins.

SIEVE, or SEARCE, an instrument serving to separate the fine from the coarse parts of powders, liquors, and the like, or to cleanse pulse from dust, light grains, &c. It is made of a rim of wood, the circle or space whereof is filled with a plexus of silk, tiffany, hair, linen, wire, or even thin slices of wood. The sieves which have large holes are sometimes also called riddles, such as the coal or lime sieve, the garden-sieve, &c. When drugs are apt to evaporate, on being passed through the sieve, it is usual to have it covered with a lid.

SIGESBECKIA, in botany, so named from John George Siegesbeck, a German, prefect of the Petersburgh garden, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: calyx exterior, five-leaved, proper, spreading, ray halved; pappus none, receptacle caffy. There are three species.

SIGHT, *sense of*. The organ of sight is a globular body, which contains within it transparent substances, fitted to form on the back part of it a picture of the object of sight. An examination of the eye of an ox will give a pretty accurate idea of the general structure of the human eye. We see in front a horny transparent substance called the cornea. Next to this is a watery fluid called the aqueous humour, in which the iris floats like a delicate curtain, with a hole in the middle called the pupil. Behind the iris we find a solid body with two convex surfaces, this is called the crystalline lens. Next to this is the vitreous humour, a jelly like, transparent substance, which fills the ball of the eye. The retina consists of exceedingly minute fibres from the optic nerve, which are spread over the whole of the back part of the inner surface of the eye. Behind the retina is a mucous or slimy matter, which in the human eye is of a dark colour, and serves to imbibe the rays of light which pass through the retina, so as to prevent the confusion which would arise from the reflection of them. The retina is the immediate organ of sight. The rays of light, proceeding from every visible point of the object of sight, enter the eye through the cornea, and pass through the pupil; they are refracted by the three humours of the eye, so as to form upon the retina an exquisitely beautiful and distinct, though minute, picture of the object. A pretty correct idea of the formation of this picture may be obtained, by carefully cutting off the back coating of an ox's eye, and holding behind it a piece of paper to receive the picture of a luminous object. For a more minute account of the structure of the eye, see ANATOMY.

What effect is produced upon the optic nerve by the formation of this picture upon the retina is not certainly known; it is sufficient for our present purpose, that, by means of the nerve, &c. the impression, whatever it be, is communicated to the mental organs, and produces in them those effects which, when attended with consciousness, are called sensations. See MENTAL PHILOSOPHY, §. 11.

If the sensation produced by the object of sight be considered unblended with the relics of other sensations, we find that it is merely what can be communicated by a minute picture on the retina. The sensation of colour can be thus communicated, and this is the only sensation which can be considered as appropriate to the sight. The sensation of figure can be thus communicated, but only of figure in two directions, length and breadth; for the picture on the retina can have only those two dimensions. The sensation of magnitude can also be thus communicated, but not of real magnitude, for the visible sensation of real magnitude cannot be conveyed by a picture, which is almost indefinitely smaller than the real object. To use the illustration of Adam Smith: "If you shut one eye, and hold immediately before the other a small circle of plain glass, of not more than half an inch in diameter, you may see through that circle the most extensive prospects, lawns, and woods, and arms of the sea, and distant mountains. You are apt to imagine that the visible picture, which you thus see, is immensely great and extensive, but it can be no greater than the visible circle through which you see it. If, while you are looking through the circle, you could conceive a fairy hand and a fairy pencil to come between your eye and the glass, that pencil might delineate upon that little glass the outline of all those extensive lawns, and woods, and arms of the sea, and distant

mountains, in the dimensions with which they are seen by the eye." Again, it is obvious, that however large, or however small, the field of view, the picture occupies an equal extent on the retina. Similar observations may be made with respect to distance. The organ of sight can convey only that sensation of distance which may be produced by a minute picture on the retina; that is, nothing but the sensation of the distances of the different parts of the picture, which may bear no proportion to the real distances, and can only be in one direction. Similar things may be said of motion, that is, change of position. The visible sensation of motion is merely that produced by the motion of different parts of the picture on the retina.

The fact is, that not the objects themselves, but the picture formed upon the retina, is the immediate object of the sight. Without the sense of touch it is probable that the picture would never have conveyed ideas of real figure, magnitude, motion, or position; still more, that it would never have conveyed the idea that external objects produced the picture. Of colour it does convey sensations, which do not receive correction from the touch, and which can be acquired by the sight alone. Persons completely blind have been known to distinguish objects of one colour from those of another, but this is by the feel of the surfaces of those objects. If they have never at all possessed sight, though they may speak of colours, and distinguish coloured objects, and even have a remote idea of the causes of our sensations of colours, yet they can have no sensations nor consequently ideas of colours. Mr. Locke mentions a blind man, who said, that he imagined the colour of scarlet resembled the sound of a trumpet.

The limits here stated of the direct power of the sense of sight may appear strange to those who have not been accustomed to distinguish between the sensation, and the perception of which the sensation forms a part. (See SENSATION.) We seem to have an immediate sensation of the real situation and magnitudes, &c. of objects, but what has been before stated is an indisputable fact. The case is, the compound idea, formed from the sensations of touch, in connection with certain visual sensations, are so early formed, and so early connected with those visual sensations, that we have no recollection of the simple idea of sensation, or of the formation of the compound idea: indeed, as active agents, we had no concern in the formation of our perceptions. There are however numerous circumstances which prove the point; the most satisfactory are those attending the obtaining of the sight, at a period when recollection can register the sensations. One such case fell under the observation of the able Cheselden, and we shall state some of the principal circumstances of it. Mr. C. couched a youth of thirteen years of age: when he was allowed to use his sight, all objects appeared to him alike to touch his eyes, as the things which he felt touched his skin. He considered solid bodies as planes differently coloured; and when he had learned to distinguish solids by their appearances, he was greatly surprised, when examining the pictures of solids, to find all the parts plane and smooth like the rest; he asked which of his senses deceived him, his sight or his hearing? Being shown a miniature of his father, which was painted on a watch-case, he at once perceived that it was a representation of his father, but expressed great surprise that so large a countenance could be contained in so small a space: it appeared to him as impossible as for a pint to hold a hogshead. Mr. Ware published in the Philosophical Transactions of 1800 a case which seemed to militate greatly against Mr. C.'s conclusions: Mr. W.'s patient from the first had ideas of distance and form. But Mr. W. himself furnishes a solution of this difficulty; for we find, from his paper, that his patient had always been able to distinguish light and vivid colours from shade.

Sensations of colour are in the early parts of life very vivid, and assist considerably in the formation of our mental pleasures; but the other sensations derived from this sense are principally important to us, as being by association the signs of the ideas derived from the touch; and from their distinctness, well calculated to serve as the connecting bond of union, and to bring again into the view of the mind those ideas. The visual sensations, of themselves considered, are seldom the objects of reflection; we seldom even think of them, and while we appear to give to the visible appearances of objects our minutest attention, we are in part attending only to the tangible qualities of which the visible appearance is the sign. Were it not therefore for association, the sight would be of little more use to us than a beautiful picture of objects with which we have no concern. But consider its value in connection with association, and it must be regarded as the most perfect and the

most permanently valuable of all the senses. The information obtained by the touch is acquired slowly; and the sensations must be continually repeated, in order to acquire information respecting new objects; but the sight takes in a vast variety of objects, and, almost at a glance, can distinguish most that is necessary to be known respecting them. Its sensations recall the past impressions derived from the touch, and at once suggest the size, the shape, the distance, of their various objects. "If a man," says Reid, "were by feeling to find out the figure of the Peak of Teneriffe, or even of St. Peter's at Rome, it would be the work of a lifetime." Besides, its discovery reaches further than the touch could carry us; it enables us to range through the vault of Heaven, and determine the motions of the heavenly luminaries. It traces in the countenance the workings of the mind; it displays the passions and affections of the soul. With association it is every thing: without it, it would be useless as the bright fleeting visions of sleep.

SIGHTS *of a quadrant*, &c. thin pieces of brass, raised perpendicularly on its side, or on the index of a theodolite, circumferentor, &c. They have each an aperture, or slit, up the middle, through which the visual rays pass to the eye, and distant objects are seen.

SIGN, in algebra, denotes a symbol or character. Mr. Maclaurin observes, that the use of the negative sign, in algebra, is attended with several consequences that at first sight are admitted with difficulty, and has sometimes given occasion to notions that seem to have no real foundation. This sign implies that the real value of the quantity represented by the letter to which it is prefixed, is to be subtracted; and it serves with the positive sign, to keep in view what elements or parts enter into the composition of quantities, and in what manner, whether as increments or decrements, (that is, whether by addition or subtraction) which is of the greatest use in this art. See NEGATIVE *sign*.

SIGNS, in astronomy. The ecliptic is usually divided, by astronomers, into 12 parts, called signs, each of which of course contains 30 degrees. They are usually called the signs of the zodiac; and beginning at the equinox, where the Sun intersects and rises above the equator, have these names and marks, Aries ♈, Taurus ♉, Gemini ♊, Cancer ♋, Leo ♌, Virgo ♍, Libra ♎, Scorpio ♏, Sagittarius ♐, Capricornus ♑, Aquariusun ♒, Pisces ♓. Of these signs, the first six are called northern, lying on the north side of the equator; the last six are called southern, being situated to the south of the equator. The signs from Capricornus to Gemini are called ascending, the Sun approaching or rising to the north pole while it passes through them; and the signs from Cancer to Sagittarius are called descending, the Sun, as it moves through them, receding or descending from the north pole. See ZODIAC.

SIGN *manual*. The King's signature is so called. All commissions in the regular army of Great Britain, army warrants, &c. bear the sign manual. The appoinments of officers in the volunteers have been so distinguished during the present war. Adjutants only in the militia have their commissions signed by the King; those of the field officers, captains, and subalterns, &c. are signed by the lords lieutenants of counties, or by their deputies for the time being, sanctioned by a previous intimation from the Secretary of State, that the King does not disapprove of the names which have been laid before him.

SIGNALS, certain signs agreed upon, for suddenly conveying intelligence to places, to which the voice cannot reach. Thus, in some countries, fires are lighted upon the hills, at the approach of danger: and at the beginning of a battle or an attack, signals are usually made with drums and trumpets. At sea they are given by firing cannon, or muskets; by lights, flags, sails, &c.

Signals at sea are made by the admiral or commander in chief of a squadron, either in the day, or by night, whether for sailing, fighting, or the better security of the merchant ships under their convoy: these are very numerous and important, being all appointed and determined by the Lords of the Admiralty, and communicated in the instructions sent to the commander of every ship of the fleet or squadron, before their putting to sea. Some of the principal of which are as follow: when a commander in chief would have them unmoor, he looses his main-top-sail, and fires a gun, which, in the royal navy, is to be answered by every flag-ship, and every ship is to get under sail as soon as she can. When, in bad weather, he would have them wear, and bring to the other tack, he hoists a pendant on the ensign-staff, and fires a gun: then the leewardmost and stern-most ships are to wear first, and bring on the other tack, and lie-by, or

go on with an easy sail, till he comes a-head. When any ship discovers land, he is to hoist his jack and ensign, and keep it abroad till the admiral answer him by hoisting his, on sight of which he is to hawl down his ensign. If any discovers danger, he is to tack and bear up from it, and to hang his jack abroad from the main-top-mast cross-trees, and to fire two guns: but if he should strike or stick fast, then, besides the same signal with his jack, he is to keep firing, till he sees all the fleet observe him, and endeavour to avoid the danger. When the admiral would have the vice-admiral to send out ships to chase, he hoists a flag striped white and red on the flag-staff at the fore-top-mast-head, and fires a gun: but if he would have the rear-admiral do so, he hoists the same signal on the flag-staff at the mizen-top-mast-head, and fires a gun. When he would have them give over chase, he hoists a white flag on his flag-staff at the fore-top-mast-head, and fires a gun; which signal is also to be made by that flag-ship which is nearest the ship that gives chase, till the chasing ship sees the signal. When the admiral would have the fleet prepare to anchor, he hoists an ensign striped red, blue, and white on the ensign-staff; and fires a gun; and every flag-ship makes the same signal.

Besides these, there are many other signals used by day; and different signals, upon these and other occasions, used by night: and others also when a fleet sails in a fog; all of which are to be found in the Book of Signals.

The signals for managing a sea-fight are also very numerous, the principal of which are as follow: when the admiral would have the fleet form a line of battle, one ship a-head of another, he hoists an union-flag at the mizen-peek, and fires a gun; and every flag-ship does the like. But when they are to form a line of battle one a-breast of another, he hoists a pendant with the union-flag, &c. When he would have the admiral of the white, or he that commands in the second post, to tack, and endeavour to gain the wind of the enemy, he spreads a white flag under the flag at the main-top-mast-head, and fires a gun: and when he would have the admiral of the blue do so, he does the same with the blue flag. If he would have the vice-admiral of the red do so, he spreads a red flag from the cap, on the main-top-mast-head downward on the back-stay; if the vice-admiral of the blue, he spreads a blue flag, and fires a gun: if he would have the rear-admiral of the red do so, he hoists a red flag at the flag-staff at the mizen-top-mast-head; if the rear-admiral of the white, a white flag; if the rear-admiral of the blue, a blue flag, and under it a pendant of the same colour, with a gun. If he would have him that commands in the second post of his squadron to make more sail, he hoists a white flag on the ensign-staff; but if he that commands in the third post be to do so, he hoists a blue flag, and fires a gun; and all the flag-ships must make the same signal. Whenever he hoists a red flag on the flag-staff at the fore-top-mast-head, and fires a gun, every ship in the fleet must use their utmost endeavour to engage the enemy in the order prescribed. When he hoists a white flag on his mizen-peek, and fires a gun, all the small frigates of his squadron, that are not of the line of battle, are to come under the stern. If the fleet be sailing by a wind in the line of battle, and the admiral would have them brace their head-sails to the mast, he hoists up a yellow flag on the flag-staff at the mizen-top-mast-head, and fires a gun, which the flag-ships are to answer, and then the ships in the rear are to brace first. After this, if he would have them fall their head-sails, and stand on, he hoists a yellow flag on the flag-staff of the fore-top-mast-head, and fires a gun, which the flag-ship must answer; and then the ships in the van must fall first, and stand on. If, when this signal is made, the red-flag at the fore-top-mast-head be abroad, he spreads the yellow flag under the red-flag. If the fleets being near one another, the admiral would have all the ships to tack together, the sooner to lie in a posture to engage the enemy, he hoists an union-flag on the flag staves at the fore and mizen-top-mast-heads, and fires a gun; and all the flag-ships are to do the same. The fleet being in a line of battle, if he would have the ship that leads the van, hoist, lower, set, or hawl-up any of his sails, he spreads a yellow flag under that at his main-top-mast-head, and fires a gun; which signal the flag-ships are to answer: and the admiral will hoist, lower, set, or hawl-up the sail, which he would have the ships that lead the van do; which is to be answered by the flag-ships of the fleet. When the enemies run, and he would have the whole fleet follow them, he makes all the sail he can after them himself, takes down the signal for the line of battle, and fires two guns out of his fore-chase, which the flag-ships

answer: and then every ship is to endeavour to come up with, and board the enemy. When he would have the chase given over, he hoists a white-flag at the fore-top-mast head, and fires a gun. If he would have the red squadron draw into a line of battle, one a-breast of another, he puts abroad a flag striped red and white on the flag-staff at the main top-mast-head, with a pendant under it, and fires a gun: if the white or second squadron is to do so, the flag is striped red, white, and blue: if the blue or third squadron is to do so, the flag is a Genoese ensign and pendant: but if they are to draw into a line of battle one a-head of another, the same signals are made without a pendant. If they are to draw into the line of battle one a-stern of another, with a large wind, and he would have the leaders go with the starboard-tacks aboard by the wind, he hoists a red and white flag at the mizen-peek, and fires a gun: but if they should go by the larboard-tacks aboard the wind, he hoists a Genoese flag at the same place: which signals, like others, must be answered by the flag-ships.

Signals, *day*, are usually made by flags and pendants, sometimes accompanied with one or more guns; and night-signals are either lanterns disposed in certain figures, as lines, squares, and triangles, or are made with false fires. Fog signals consist of operations which emit sound, as firing cannon or muskets, beating drums, &c.

Signals, in military actions. In former times large pieces of wood were hung above the towers of cities or castles, which, by being drawn up or lowered, gave intelligence of what passed. This method has been succeeded by the invention of telegraphs, which answer every purpose of communication, when they can be established through any extent of country. Besides those signals, there are others which may be called vocal and demi-vocal. The vocal signals are those of the human voice, which consist in the necessary precautions that are adopted to prevent a guard or post from being surprised, to enounce words of command in action, &c. Of the first description are paroles and countersigns, which are exchanged between those to whom they are intrusted, and which are frequently altered, during the day and night, to prevent the enemy from receiving any information by means of spies. The demi-vocal signals are conveyed by military instruments, the different soundings of which indicate, instantaneously, whether an army is to halt or to advance, whether troops are to continue in the pursuit of an enemy, or to retreat.

The demi-vocal signals, directed to be observed in the British service, as far as regards the manœuvring of corps, &c. consist of signals for the government of light infantry, and of cavalry regiments, squadrons, or troops: the latter are properly called soundings. Light infantry signals are to give notice to advance, to retreat, to halt, to cease firing, to assemble, or call in all parties. In the regulations printed by authority it is observed, that these signals are to be always considered as fixed and determined ones, and are never to be changed. The bugle horn of each company is to make himself perfect master of them. All signals are to be repeated, and all those signals which are made from the line or column, are to convey the intention of the commanding officer of the line to the officer commanding the light infantry, who will communicate them to the several companies or detachments either by word or signal.

SIGNATURE, in printing, is a letter put at the bottom of the first page at least, in each sheet, as a direction to the binder, in folding, gathering, and collating them. The signatures consist of the capital letters of the alphabet, which change in every sheet: if there be more sheets than letters in the alphabet, to the capital letter is added a small one of the same sort, as A a, B b; which are repeated as often as necessary. In large volumes it is usual to distinguish the number of alphabets after the first two by placing a figure before the signature, as 3 B, 4 B, &c.

SIGNET, one of the king's seals, made use of in sealing his private letters, and all grants that pass by bill signed under his majesty's hand: it is always in the custody of the secretaries of state.

SILENE, in botany, *catchfly*, a genus of the Decandria Trigynia class and order. Natural order of Caryophyllei. Caryophylleæ, Jussieu. Essential character: calyx ventricose; petals five, with claws, crowned at the throat; capsules three-celled. There are sixty-six species.

SILICA, in mineralogy and chemistry, is generally found in a stony state, and from its forming nearly the entire composition of flint, it has acquired the name of silica, silex, or siliceous earth. This earth exists in great abundance in nature, and it constitutes the basis of some of the hardest stones of which the nucleus of the globe

consists; and, on account of its great abundance, it has been regarded as the primitive or elementary earth, the base of all the other earths.

Silica forms one of the constituent parts of most stony bodies; but it exists in greatest abundance in agates, jasper, flints, quartz, and rock crystal: in the latter it exists nearly in a state of purity. To obtain it perfectly pure, a quantity of quartz, or rock crystal, may be exposed to a red heat. When it is taken from the fire, and while it is yet hot, it is suddenly immersed in cold water. It is then to be reduced to powder, and if transparent rock crystal has been employed, it is then in a state of tolerable purity. To have it perfectly pure, mix one part of the pounded stone with three parts of potash, and expose them in a crucible to a heat which is sufficient for the fusion of the mixture. The mass thus obtained is soluble in water. Add a sufficient quantity of water for its solution, and drop in muriatic acid as long as there is any precipitate. Let this be repeatedly washed with water and dried. The substance thus obtained is pure silica. It is in the form of very fine white powder, which has neither taste nor smell. The particles are rough and harsh to the feel, as when they are rubbed between the fingers, or touched with the tongue. The specific gravity is 2.6. Light has no action on silica, and it is one of the peculiar characters of this earth, that it resists, unchanged, the greatest degree of heat. There is no action between silica and oxygen, azote, or hydrogen; nor is it changed by exposure to the air. It is not acted upon by carbon, phosphorus, or sulphur. It is insoluble in water; but, in a state of minute division, it absorbs a considerable portion, and forms with this liquid a transparent jelly. When it is exposed to the air, the whole of the moisture is evaporated.

Silica is frequently found in nature in the crystallized form, and then it is distinguished by the name of rock crystal. It is most commonly in hexagonal prisms, terminated by hexagonal pyramids. Crystals of silica have also been formed artificially. In a solution of silica in fluoric acid, which had remained at rest for two years, Bergman found crystals, some of which were cubes, and some had truncated angles, at the bottom of the vessel. Crystals of silica have also been formed, by diluting largely with water the combination of silica and potash, and allowing it to remain for a long time.

Silica is only acted on by a very few of the acids. These are the phosphoric and boracic, which combine with it by fusion, and the fluoric, which dissolves silica either in the gaseous or liquid state. When silica is held in solution in water by means of an alkali, it is also dissolved by the muriatic acid. The alkalies have a very powerful action on this earth. In the preparation of the pure earth, it was combined with potash by means of fusion. This compound is different in its nature and properties, according to the proportions of the silica and the alkali. Two or three parts of potash, with one of silica, form a compound which is deliquescent in the air, and soluble in water. This was formerly distinguished by the name liquor silicum, or liquor of flints. It is now called silicated alkali. When this solution is long exposed to the air, the earth is deposited in a flaky gelatinous form. It is decomposed by acids, which combine with the alkali, and the pure earth falls to the bottom in the state of fine powder. When the solution is largely diluted with water, and if a greater quantity of the acid be added than is sufficient to saturate the alkali, the silica remains in solution. This is particularly the case when the muriatic acid is employed; but when the silica is in greater proportion, a compound is formed which is possessed of very different properties. The substance thus obtained is glass. This earth also enters into combination with some of the earths. If to a solution of the liquor of flints lime-water be added, a precipitate is formed, which is found to be a compound of silica and lime. Silica also combines with lime by means of heat, and in certain proportions a glass is formed. Silicious earth enters with difficulty into combination with magnesia; but if equal parts of silica and magnesia be exposed to very strong heat, they melt into a white enamel. But the most important compounds of the earths are those of silica and alumina. These earths may be combined together, as appears from the experiments of Guyton, in the humid way. He mixed together equal parts of alumina dissolved by means of potash, and of silica held in solution by the same alkali. When the solutions came into contact, a brown zone was immediately formed, which spread, by agitation, through the whole mass, and communicated to it a yellowish colour. The mixture was no further changed during the

space of an hour, although it was occasionally stirred with a glass rod; but at the end of that time the whole mass assumed the appearance of a thick, opaque white jelly. When the silica and alumina are mixed together, and formed into a paste with water, and exposed to heat, they strongly cohere, and assume a considerable degree of hardness. This compound forms the basis of all kinds of pottery and porcelain.

Barytes and strontian in some degree dissolve silica as the alkalies do. Two hundred parts of strontian, with sixty of silica, heated intensely in a crucible for an hour, produced a grey sonorous rifty mass, with only a slight caustic taste. This being boiled in water, was partly dissolved, but could not be crystallized. Saturated with nitric acid, it gave, by evaporation, a copious jelly, which was pure silex. A similar result was obtained when barytes was used instead of strontian.

SILIQUA, in botany, a species of pod, in which the seeds are alternately fixed to either suture or joining of the valves; in this it differs from the legumen, which has its seeds attached to one suture only. This kind of seed vessel is found in all the class Tetradynamia of Linnæus. See LEGUMEN.

SILIQUOSÆ, in botany, the name of the thirty-ninth order in Linnæus's Fragments of a Natural Method, consisting of plants that have a siliqua for a seed vessel. It is divided into two sections: 1. Those which have cross-shaped flowers with long pods, as the brassica, cabbages, raphanus, radish; sinapis, mustard, &c. 2. Those with cross-shaped flowers with short round pods, as the iberis, candy-tuft. This order chiefly furnishes biennial and perennial herbs of an irregular figure. The roots are long, branched, crooked, and fibrous; those of the turnip and radish are succulent and fleshy; the flowers are hermaphrodite, and in the greater number disposed in a spike at the extremity of the branches. They are easily rendered double by culture. The stamina are six in number, two of which are of the length of the calyx, and the remaining four somewhat longer, but shorter than the petals. The seed-vessel, as we have observed, is a long pod in plants of the first section; a short and round one in those of the second. The seeds are roundish, small, and attached alternately by a slender thread to both sutures, or joining of the valves.

SILK, the web or envelopment of the caterpillar, of a species of moth called the Phalena mori; which being convertible to various purposes of utility and elegance, forms an important article in commerce, as the material of a valuable manufacture. The caterpillar, or silk-worm, when full grown, encloses itself in a loose web, in the midst of which it forms a much closer case or covering, of an oval form, and varying in colour from white to a deep orange, but usually of a bright yellow colour. In this case, or ball, the animal becomes a chrysalis, and remains enclosed about fifteen days; when having resumed active life, in the form of a moth, it makes a hole at one end of its prison and comes out. This, as it destroys the silk-ball, is prevented in those countries where silk is cultivated, by killing the chrysalides by means of heat. See PHALENA.

The silk-worm is supposed to be a native of China, at least the Chinese were the first nation in the world acquainted with the manufacture of silk. It was little known in Europe before the time of Augustus. Galen, who lived about the year 160, mentions silk as in use no where but at Rome, and only among the rich. The Emperor Heliogabalus, who died in the year 220, is said to have been the first man that wore a holosericum, or dress, made wholly of silk; princes, as well as subjects of the greatest quality, wearing only a stuff made of silk mixed with other materials. In the time of Aurelian, silk was sold in Rome for its weight in gold, and long continued to bear a great value, from the expense attending the mode in which it was procured. The only silk then known was that of China, which was brought from thence, in the raw state, to Berytus and Tyre, in Phœnicia, where it was manufactured; but this branch of commerce being interrupted by the conquests of the Scythians, the Emperor Justinian became desirous of establishing the culture of silk within his dominions; for which purpose he employed two Monks, who had been in India, to procure the eggs of the insect from China. This was accomplished about the year 555; the eggs were hatched at Constantinople, and the breed of the insect being carefully encouraged, raw silk was soon produced in abundance, which was worked up into manfactures at Athens, Thebes, Corinth, and other places. It appears, however, that for many years after the establishment of the culture of silk in Greece, garments of this material

tities of silk made. It does not, however, appear that the culture of silk has since been carried to any considerable extent in Virginia, which is probably owing more to the attachment of the planters to the growth of tobacco than to any natural impediment.

The settlement of the colony of Georgia was begun in the year 1732, and the trustees, soon after the commencement of their undertaking, caused a common nursery garden to be laid out for white mulberry trees, for the production of silk. It was at this time raised in Carolina, in small quantities, some families making about forty or fifty pounds weight in the year. In order to instruct the colonists of Georgia upon this subject, some persons from Piedmont in Italy, skilled in tending the worms and the winding of silk, were sent thither; and, notwithstanding the difficulties attending the attempt, and the public misfortunes of the colony, many persons persevered and experienced some success; an act of parliament was in consequence passed, in 1749, for encouraging the culture of raw silk in the American colonies, by which raw silk, certified to be the real growth and culture of those colonies, was exempted from any duty on importation into the port of London. The culture increased gradually, though slowly, both in Georgia and the adjoining province of South Carolina; but a few years after the produce became more considerable. In the year 1757, 1,052*lbs*. weight of silk-balls were received at the filature in Georgia, and the next year produced no less than 7,040*lbs*. weight thereof. In 1759, there were received at Savannah, the capital of Georgia, considerably above 10,000*lbs*. weight of raw silk, although it was thought an unfavourable season. As the culture of this valuable article thus appeared to be making some progress in the southern colonies, an act of parliament was passed, in 1769, for the further encouragement of the growth of raw silk in America; by which a bounty was granted of 25*l*. for every 100*l*. value of such raw silk for the next seven years, and lesser bounties during the two following periods of seven years. The Society for the encouragement of Arts, Manufactures, and Commerce, also offered large premiums for encouraging the same object; but still the quantities raised were but small, and the cost too great for competition with silk from other parts.

There can be no doubt that in many parts of the southern states of America, the climate is as favourable to the mulberry tree and the silk-worm, as in those countries in Europe where they are raised; the chief difficulty the Americans have to contend with respecting this article is, that in most of the southern states, the labourers are Negro slaves, who are not sufficiently attentive and skilful in this business.—In Connecticut, where there is a sensible and careful white population, and where land is comparatively scarce and dear, the culture of silk has been found to be practicable and profitable. A project to extend the white mulberry tree over all the States was formed a few years ago, in consequence of which a considerable number were planted. An extensive nursery of these trees was established near Philadelphia, in 1789; another at Princeton, in New Jersey; and two more in New York, and Long Islands. The idea upon which these nurseries were principally encouraged was, that they prepared the States for the reception of emigrants from silk countries; but no considerable emigration from those countries has taken place.

In the British settlements in the East Indies, the culture of silk has been long established, particularly in the island of Cossimbwzar and its neighbourhood, in the province of Bengal; and since, about the year 1760, when the company became the rulers of the country, and adopted a new system of trade for the purpose of realizing the surplus revenue, the culture of raw silk has been promoted, and the quantity considerably increased. Of late years, considerable attention has been paid both to the quality of the silk, and to the mode of reeling it, by which it has been very materially improved, so as to rival, in most respects, the produce of Italy.

There are eight principal silk factories belonging to the company in Bengal; and in every filature, or factory, there are employed, according to its size, from three thousand to ten thousand people; and if to these are added the mulberry-planters, worm feeders, &c. from ten thousand to forty thousand men, women, and children, are attached to each filature. Attempts have been made to introduce the silk-worm in other parts of the company's possessions, especially on the coast of Coromandel. Dr. James Anderson, of Fort St. George, who has been particularly zealous in promoting this among other useful undertakings, introduced mulberry trees at Madras, about the year 1770, and finding they grew luxu-

tiently, afterward endeavoured to procure silk worms' eggs from Bengal: his two first attempts were unsuccessful, but the third in 1789 succeeded, and the advantages likely to accrue from the culture of silk soon engaged several persons on different parts of the coasts in breeding the worms. In a letter to Sir Joseph Banks, dated 20th January, 1792, he says, "I have received accounts of the success of the silk worms at Palamcotta and Masulipatam, as well as of the recovery of those that had been diseased by the late rains at Tritchinopoly, so that a breed of this insect is already established in an extent of six hundred miles upon the coast, but it will rest with the company to render it productive."

The establishment of the silk manufactory in Great Britain affords one of the most complete instances in which an art borrowed entirely from other nations, and employed on a material entirely of foreign growth, has been brought to such perfection in this country, as to equal, and in some instances to surpass, the productions of those countries from which it was derived. The use of silk was introduced into this country gradually, being at first confined to small ornamental articles. In the year 1455 there appears to have been a company of silk women in England, who most probably only used silk in embroidering and other kinds of needle-work, but their performances at least contributed to bring this elegant material into more general notice. By an act of Henry VIIth, entitled "Silk-work," it appears that about 1504, the smaller manufactures of silk were executed in England, as it was among other things enacted, that from thenceforth no person should import into England for sale any kind of silk wrought by itself or with any other material in any place out of the realm, in ribbands, laces, or girdles; but none of the more important branches of the manufacture could then have existed here, or such goods would certainly have been included in the prohibition. The King sometimes obtained a pair of silk stockings, which were brought from Spain, the making of silk hose not having yet been attempted in England, it was, however, introduced about the year 1561, when Queen Elizabeth was presented with a pair of black silk knit stockings, and is said to have been so pleased with them, that she never wore cloth hose after. Elizabeth's fondness of dress must have inclined her to countenance every branch of this manufacture, but, little was done for its improvement till the reign of her successor, whose active measures for establishing the culture of silk, and increasing the importance of the manufacture in this country, were by no means fruitless. The broad-silk manufacture was introduced here about the year 1620; and a Mr. Burlamach, a merchant much employed by the King, by his direction brought from abroad silk throwsters, dyers, and broad weavers, whose assistance so materially contributed to the improvement and increase of the manufacture, that in 1630 it was thought proper to incorporate the silk throwsters of London, and within four miles thereof, and in the following year the silk-men were likewise incorporated: the weavers had been incorporated long before. In addition to these favours from Charles I. he endeavoured to protect the trade from what appeared to be an improper practice, by issuing a proclamation respecting the increase of weight of silk dyed black upon the gum, which was then considered as a great fraud, and prohibited accordingly; but upon better information the King thought proper, in 1638, to revoke this prohibition. About the same time a new charter was granted to the Weavers' Company, and by a proclamation issued soon after, they were empowered to admit into the freedom of their company, a competent number of such persons, as well strangers as natives, as had exercised the trade of weaving at least one whole year, before the date of the new charter, "who shall be conformable to the laws of the realm, and the constitutions of the Church of England." It has been justly asked, What had the constitution of any church to do with the trade of weaving? What other political qualification could be requisite but that the weaver should be a peaceable subject, and, considering the times, a Protestant of some denomination or other? But many similar instances may be found, in which bigotry and party zeal imposed injudicious restrictions on trade and manufactures.

In 1661 the silk throwsters petitioned parliament, in order obtain the legislative sanction to some regulations that were thought necessary for the security of their trade, which they asserted employed above forty thousand men, women, and children; and, in consequence of this application, the privileges of the company were extended to twenty miles round London, and it was enacted that none should set up

the trade of a silk-throwster, but such as had served seven years apprenticeship to it, and should make themselves free of the company.

In 1680 the Weavers' Company petitioned the House of Commons, against the importation of foreign silks from France, and the wear of East India wrought silks, which had then become very general, but it does not appear that any thing was done in consequence of this application. The Turkey Company about the same time renewed a complaint they had before made at different times against the East India company for importing raw silk; this article having formerly been wholly imported from Turkey, and being a valuable branch of the commerce of that company, which they were now rapidly loosing, it induced them soon after to make a formal complaint to the Privy Council, on which occasion, among other assertions, they denominated the new silk which had been imported from Bengal, "a deceitful sort of raw silk." The India Company, unable wholly to deny this charge, contented themselves with saying, that, with respect to the quality of Bengal silk, it was like all other commodities, good, bad, and indifferent; and rested their defence chiefly on the more general ground of the importance of the manufacture, and the propriety of encouraging it, asserting that raw silk had become so essential, that it might be compared with sheeps' wool and cotton wool, and that since their importation thereof, the silk manufacture had increased in the proportion of one to four. This contest between the two companies for the importation of raw silk, proves that it was a valuable branch of trade, and it appears that the manufacture was increasing rapidly, but nothing contributed so much to its full establishment in this country as the cruel persecution of the Protestant Christians in France, on the revocation of the Edict of Nantes, in 1685. Of the multitudes who fled at that period, upwards of fifty thousand took refuge in England, the greater part of whom settled in the suburbs of London, those who had been engaged in silk-weaving, chiefly fixed their residence in Spitalfields, where they added to the branches of this art already known, those of modes and lustrings, which articles had hitherto been imported from France, they also instructed our weavers in brocades, satins, mantaus, and velvets. Soon after the revolution, in consequence of the war, an act was passed prohibiting all trade and commerce with France, a measure which must have co-operated very materially with the arrival of the new workmen to the success of the silk trade in this country, as the annual importation of French silks had been very great for some years before. In 1692, lustrings and modes being much in fashion, and the fabrication of them but recently introduced here, the makers for their encouragement had a patent granted them, and soon brought this branch to the greatest perfection; upon which, about five years after, foreign lustrings and modes were entirely prohibited, and the sole privilege of making these silks confirmed to the company by Act of Parliament, for the term of fourteen years; but with the change of fashion this company came to nothing. In 1697 the weavers of London became very tumultuous, on account of the great quantities of silks, stained calicoes, and other Persian and Indian manufactures imported by the East India Company, and worn by all sorts of people.

To remedy these complaints, a bill was brought into parliament to restrain the wearing of these foreign goods, and the House of Lords heard council and witnesses for and against it: the India Company on this occasion engaged the celebrated Dr. Davenant to write in their defence, who in his Essay on the East India Trade, asserted that since the goods imported by the company had been in use, the price of silks from France, Spain, and Italy, had fallen at least twenty-five per cent; and endeavoured to show that the intended prohibition would be destructive to the India trade in general, and hazard its being utterly lost to this country. The contention between the old and new East India Companies greatly increased the importation of India wrought silks and calicoes, and the wear of them became universal till prohibited by an act of parliament passed in 1700.

In 1713, the Weavers' Company, alarmed at the tendency of a treaty of commerce which had been concluded with France, under which the general introduction of French silks would soon have ruined the English manufacture, petitioned parliament against the bill for rendering effectual the eighth and ninth articles of the treaty, and in their petition they represent the state of the manufacture at that period in the following words. "That by the encouragement of the crown, and of divers acts of parliament, the silk manufacture is come to

be above twenty times as great as it was in the year 1664, and that all sorts of as good black and coloured silks, gold and silver stuffs and ribbons, are now made here as in France. That black silk for hoods and scarfs, not made here above twenty five years ago, hath amounted annually to above three hundred thousand pounds for several years past, which before were imported from France, &c." As not only persons concerned in the silk trade, but most other manufacturers and merchants, were against the articles of the treaty which caused this petition, the bill was rejected by the House of Commons, to the great joy of the drapers, mercers, and weavers of London, who expressed their satisfaction at the event by bonfires and illuminations.

A few years after, the art of throwing fine raw silk into organzine was introduced into this country by Messrs. Thomas and John Lambe, but some impediments arising to the success of the undertaking, their machinery was afterwards applied to throwing tram and singles. See ORGANZINE.

The decline of the Turkey trade being attributed at this period to the French exporting woollens to Turkey and taking raw silks in return, which were afterwards brought from Italy into this country, an act was passed prohibiting the importation of raw silk the produce of Asia, from any ports in the Straits or Levant seas, except such ports and places as are within the dominions of the Grand Seignior. It was also thought proper to pass an act for encouraging the consumption of raw silk, by rendering more effectual a former act respecting the trifling articles of buttons and button-holes. In 1721, a much more important act was passed, allowing drawbacks on different descriptions of manufactured silk goods, when exported. In 1750, an act was passed for reducing the duties then payable on the importation of China raw silk to the same duty as was payable on raw silk imported from Italy, which was certainly an advantage to the manufacture, China silk being of a quality peculiarly adapted to several purposes, particularly in the gauze branch, which at one time consumed a large proportion of it, though it has since become inconsiderable. By the act just mentioned the East India Company were enabled to increase with advantage their import of silk, which at that time was not very considerable, raw silk being still principally brought from Turkey.

Total quantity of raw silk imported into Great Britain in the year 1750.

From Flanders	1,407*lbs.*
Spain and Portugal..	2,564
Streights.........	14,897
Italy	36,301
Turkey........	132,894
East Indies...........	43,876
	231,939

In 1763 an act was passed for rendering more effectual the act of 19 Henry VII. by imposing fines on the importers or venders of the articles therein prohibited, in addition to the forfeiture of the goods. This measure, though it might in some degree check the introduction of foreign articles, was by no means adequate to the object it had in view, as the importation still continued, which from the jealousy and discontent it excited among the workmen in this manufacture, appeared likely, in the beginning of the year 1765, to be attended with serious consequences. The journeymen weavers and others connected with the trade, who conceived themselves injured by the common use of French silks, assembled in Spitalfields and Moorfields by beat of drum, in order to petition parliament for redress by a total prohibition of such articles, and from thence proceeded in different bodies to St. James's and Westminster Hall. This disposition, and the report that the weavers in the inland towns were coming to London to join their distressed brethren, excited considerable alarm, they were, however, prevented from committing any great outrage, and finally appeased by a seasonable subscription for their relief, and an association among the principal mercers to recal all the orders they had given for foreign manufactures. An act was also passed prohibiting the importation of foreign manufactured silk stockings and gloves into Great Britain and the British dominions, and for rendering more effectual the act passed in 1763 for prohibiting other articles. For the encouragement of the throwing part of this manufacture, an act was likewise passed in 1765, for reducing the duties than payable on the importation of raw silk, for allowing a drawback on the exportation of raw and thrown silk to Ireland, and for prohibiting the exportation of raw silk from Ireland. In the next year, an act was passed to prohibit the importation of foreign manufactured silks and velvets, and for prevent-

ing unlawful combinations of workmen employed in the silk manufacture; the preamble to the act stated, that great quantities of foreign wrought silks and velvets were daily brought into and sold in Great Britain. By another act a heavy additional duty was imposed on Italian silk-crapes and tiffanies, imported into this country.

Towards the end of the year 1767, it was determined that all future court mournings should be shortened to one half of the time, which had been usually observed. This was considered particularly beneficial to the silk manufacture, and the Weavers' Company presented an address to his Majesty on the occasion, in which they assured him that his benevolent resolution would "greatly promote the silk manufactures of this kingdom, give great spirit to the trade, tend to the improvement of it in many branches, and be the means of giving constant employment to the workmen, many of whom, owing to the late mournings, have been out of employ, and in want of bread." They also expressed their obligations to the Queen and the rest of the royal family, for their patronage and encouragement of the silk manufacture. An address was likewise presented on the same occasion, signed by all the principal merchants, manufacturers, and others connected with the silk trade.

The journeyman weavers, probably supposing, that by their combination and riotous proceedings a few years before, they had obtained the exclusion of foreign silks, now adopted the same mode for obtaining an advance in the prices paid for workmanship, which being resisted by their employers, the men proceeded to the most disgraceful acts of violence and atrocity, associating together under the name of cutters, and going about in parties at night, disguised and armed with pistols, cutlasses, and other weapons; breaking into the houses of those workmen who did not join them, but followed their employ as usual, and cutting to pieces and destroying all the silk they found in the looms of such workmen. The value of the silks thus destroyed was very considerable; and, in some instances, they ill-treated or murdered those whom they found at work. Several were brought to justice; but it was a considerable time before this lawless disposition entirely subsided. In a dispute between masters and workmen, respecting pay, the opposite interests of the parties must always render it difficult to come to an amicable adjustment, and after various attempts in this instance, an act was passed in 1773 to authorise the magistrates of the cities of London and Westminster, the county of Middlesex, and the liberty of the Tower, to settle the pay of the workmen in the different branches of this manufacture, in their respective districts.

On the extension of the war in 1779, much inconvenience was experienced from the want of a sufficient supply of Italian thrown silk, caused in a great measure by an act of 2 William and Mary, by which the importation of Italian thrown silk was prohibited, unless imported according to the Navigation Act, and directly by sea from some of the ports of the country of its growth or production: this regulation was therefore now suspended, and organzine silk, of the growth or production of Italy, was permitted to be imported from any port or place, or in any ships or vessels whatsoever. In consequence of this permission, the silks of Italy were brought to England by a circuitous rout over land, and imported from Ostend and other ports of Flanders, till the peace. At a period of the war when the falling off of the silk trade was very considerable, Mr. John Callaway, of Canterbury, fortunately introduced a new article, which afforded employment to many hands. It was called Canterbury muslin, by which name it is still known, and many elegant varieties having been produced, it gives employment to many hundred persons in London and elsewhere.

As the prohibition of the importation of foreign manufactured silks did not extend to Italian crapes and tiffanies, which were permitted to be imported under a heavy duty, it was thought proper, in 1791, in consequence of improvements in the manufacture of these articles, to restrict this permission, by prohibiting the importation of silk crapes and tiffanies, of the manufacture of Italy, unless brought directly from thence, and by discontinuing the allowance of drawback on exportation.

The continual frauds committed by the different classes of persons employed in this manufacture, by purloining part of the silk entrusted to them, and resorting to various expedients for increasing the weight of the remainder, which frequently rendered the part stolen but a small part of their employers' loss; and the difficulty of convicting the persons who encouraged these practices by purchasing the stolen silk, caused an act to be passed in 1792, by which persons buying or receiving, in any manner, silk, from

those employed to work it up, knowing them to be so employed, and not having the consent of the employer, are liable to punishment by fine, imprisonment, or whipping, although no proof should be given upon the trial, to whom the silk actually belonged.

In the year 1793, this manufacture was affected more, perhaps, than any other, by the general commercial distress which then prevailed. The merchants, and particularly the East India Company, had large quantities of silk in their warehouses, and the manufacturers were over-stocked with goods, which brought the trade into a state of almost complete stagnation, by which most of the workmen engaged in it were thrown out of employ, and experienced great distress. A public subscription was opened for their relief, and very liberally supported, from which the unemployed workmen and their families were supplied with bread, and when, from the approach of winter, their necessities increased, the relief was extended to other essential articles. By the report of the committee who superintended the distribution, it appeared that there were given away 795 chaldrons of coals, 583 pair of blankets, and in bread, 121,741 quartern loaves. It was considered as a moderate computation, that 5,000 persons were totally unemployed, and that 5,000 more were only about half employed.

In the course of the succeeding three or four years, the manufacture recovered its usual activity, and in the year 1798, was in a more flourishing situation than it had been in for several years previous. In the following year, the revival of velvets, as an article of female dress, proved very favourable to the workmen, as it rendered the employment of a greater number of hands necessary; and in 1800, few persons in this line were out of employ, although the trade was somewhat checked by a considerable advance in the prices of raw and thrown silks.

TOTAL QUANTITY OF SILK IMPORTED INTO GREAT BRITAIN.

	Bengal Raw.	China Raw.	Italian and Turkey Raw.	Thrown Silk.	Total.
In 1801	351,825 *lbs.*	131,335 *lbs.*	255,951 *lbs.*	275,149 *lbs.*	1,014,260 *lbs.*
1802	111,737	75,588	372,404	396,210	955,939
1803	405,631	74,538	323,630	384,764	1,188,563
1804	624,878	90,362	317,141	449,182	1,481,563
1805	844,659	72,041	267,850	433,272	1,617,822

The annual quantity imported, on an average of the above years, is 1,251,629 pounds, from which, deducting 79,206 pounds, the average quantity of raw and thrown silk exported during the above period, it leaves 1,172,423 pounds for the quantity consumed in the manufacture. Hence it appears, that the total annual value of this manufacture must be about 3,500,000*l.* of which but a small proportion is destined for exportation, the total annual value exported being about 700,000*l.*; more than half of which goes to America. During the year 1808, the exportation to America was suspended, and at the same time, the interruption of commercial intercourse with the continent of Europe stopped, for a considerable time, the usual supply of silk from Italy; from which circumstances, the manufacture was brought into a very unprecedented situation; silk being sold in London at prices far greater than had ever been given before, while many of the masters were obliged to discharge the principal part of their workmen, from the demand for silk goods having, for a time, almost entirely ceased. These temporary embarrassments all manufactures are liable to, particularly such as, like this, depend on other countries for their materials.

Silk, in chemistry, in its natural state, contains a kind of yellow, resinous matter, which gives its fine golden colour. When raw, silk is infused in water, a portion of gummy matter is dissolved, and a light amber-coloured liquor is produced. Alcohol extracts a much deeper yellow, and makes a tincture that loses none of its colour by long exposure to the sun-beams, which bleaches the silk itself. Nitrous acid acts powerfully on silk; but, when concentrated nitric acid is distilled off silk, and the remaining liquor duly evaporated, much oxalic acid is obtained, and the residue, if evaporated still further, yields, with the remaining oxalic acid, a quantity of yellow, granular crystals, extremely bitter, not acid, and staining the saliva and hands of a deep yellow, not easily removed. If the liquor is previously saturated with potash,

and evaporated, another yellow silky salt separates, which detonates on coals like common nitre, and appears to be a triple combination of the former bitter substance with nitrate of potash.

SILPHA, in natural history, the *carrion beetle*. Antennæ clavate, the club perfoliate, shells margined, head prominent, thorax somewhat flattened margined. There are about 140 species, divided into sections. A. Lip dilated, bifid, jaw one-toothed. B. Lip rounded entire, jaw one-toothed. C. Lip horny, entire, jaw bifid. D. Lip emarginate, conic; jaw bifid. E. Lip heart-shaped, emarginate, crenate. F. Lip square, emarginate. G. Lip long, entire, antennæ serrate. H. Lip and jaw unknown. The insects of this genus are usually found among decaying animal and vegetable substances, frequenting dunghills, carrion, &c. and deposit their eggs chiefly in the latter. The larvæ are of a lengthened shape, roughened with minute spines and protuberances. S. vespillo is the most remarkable among European species: this is not uncommon in our own country. This animal is about three quarters of an inch long, and is distinguished by having the wing-sheaths considerably shorter than the abdomen. It seeks some decaying animal substance in which it may deposit its eggs, and for the greater security contrives to bury it under ground. Sometimes three or four insects, working in concert, have been known to drag under the surface the body of a mole in the space of an hour, so that no trace of it has appeared above ground: the eggs are white and oval. from these are hatched the larvæ, which, when full grown, are more than an inch long. Each larva forms for itself an oval cell in the ground, in which it changes to a yellowish chrysalis, resembling that of a beetle, out of which, in somewhat less than three weeks, proceeds the perfect insect. This species diffuses a strong and unpleasant smell, it flies with considerable strength and rapidity, and is generally seen on the wing during the hottest part of the day.

SILPHIUM, in botany, a genus of the Syngenesia Polygamia Necessaria class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: calyx squarrose, seed down, margined, two-horned; receptacle chaffy. There are eight species.

SILVER, which is divided by mineralogists into three species, the native, antimonial, and the arsenical, has been reckoned among the noble or perfect metals, and has been known from the earliest ages of the world. Its scarcity, beauty, and utility, have always rendered it an object of research among mankind, so that the nature and properties of this metal have been long studied and minutely investigated. In the midst of the rage for the transmutation of metals which for centuries fired the imaginations of the alchymists, silver occupied a great share of their attention and labour, with the hope of discovering the means of converting the baser and more abundant metals into this, which is more highly valued on account of its scarcity and durability. When the dawn of science commenced, and its light had dissipated the follies and extravagancies of these pursuits, the earlier chemists were much employed in examining the properties and combinations of silver; nor has it been overlooked or neglected by the moderns. Silver, which is neither in such abundance nor so universally diffused as many other metals, exists in nature in five different states: in the native state; in that of alloy with other metals, especially with antimony, in that of sulphuret, sulphurated oxide, muriate, and carbonate.

1. Native silver, which is characterized by its ductility and specific gravity, is frequently tarnished on the surface, of a grey or blackish colour, and appears under a great variety of forms. In this state it is not perfectly pure. It is usually alloyed with a little gold or copper.

2. The alloy of silver and antimony, which is the most frequent, is distinguished by its brittleness and lamellated structure from native silver, which it resembles in lustre and colour. It crystallizes in prisms, which are six-sided, and pretty regular.

3. The sulphuret of silver, which is known to mineralogists by the name of vitreous silver ore, is of a dark grey colour, and has some metallic lustre. It is usually crystallized in the form of cubes, octahedrons with angular facets, or sometimes in the form of the dodecahedron.

4. The sulphurated oxide of silver and antimony. In this ore of silver the sulphur is combined with the metal in the state of oxide; in the former, in the metallic state. This ore is called red silver ore. It is of a deep red colour, sometimes transparent, and sometimes nearly opaque, frequently having the lustre of steel on the surface. The primitive form of its crystals is the rhomboidal dodecahedron.

5. The muriate of silver, which has been

long known to mineralogists by the name of corneous silver, is found in irregular masses of a greyish colour, frequently opaque, but sometimes semi-transparent. It is soft, and very fusible.

Native silver is generally found in irregular shapes, sometimes in masses of no determinate form, sometimes branched, occasionally in capillary filaments, and not uncommonly in leaves. Thus it appears in most mines, and particularly in those of Siberia, where Patrin tells us he never met with it crystallized. It is found in the mines of Peru in a vegetable form, imitating the leaves of fern. This variety of figure in native silver is occasioned by a vast number of little eight sided crystals, so disposed upon each other as to give the whole the appearance of a vegetable. The curved cylindrical filaments, in which form silver is sometimes found, are of various sizes, from the thickness of a finger to the diminutive size of a hair. Native silver, as we have observed, is seldom found pure, but is generally mixed with other metals, such as gold, copper, mercury, iron, lead, &c. This last metal almost always contains a portion of silver, though frequently so small as not to be worth the expense of separating it. In the reign of Edward the First nearly 1600 pounds weight of silver were obtained, in the course of three years, from a mine in Devonshire, which had been discovered about the year 900. The lead mines in Cardiganshire have, at different periods, afforded great quantities of silver. Sir Hugh Middleton is said to have cleared from them 2000 pounds in a month. The same mines yielded, about the year 1745, eighty ounces of silver out of every ton of lead. The lead ores from Brunghill and Skekorn produced also a considerable quantity of silver. The lead only, in one of the smelting-houses at Holywell, in Flintshire, produced no less than 31,521 ounces, or 5126¾ pounds of silver, from the year 1754 to 1776. "There are some lead ores in this country," says Dr. Watson, "which, though very poor in lead, contain between three and four hundred ounces of silver in a ton of that metal. It is commonly observed, that the poorest lead-ores yield the most silver, so that a large quantity of silver is probably thrown away in England, from not having the poorest sort of lead-ores properly assayed."

Silver in its mineral state occurs massive, disseminated, in blunt cornered pieces, in plates, and in membranes: it is said to occur also in Spanish America in rolled pieces. Its crystallizations are very various, as the cube, octahedron, prism, pyramidal, &c.: the crystals are small and microscopic. It is chiefly found in primitive earths, especially in those which are deposited in beds, though it is not confined to these alone. It is very rarely met with in granite, but not uncommonly in the fissures of micaceous rocks, and in other places of a similar nature, but of more recent formation. In the secondary earths silver often occurs, being found in chalk, slate, &c.; but almost always mineralized by sulphur or arsenic. It is a singular fact that the situations of gold and silver mines should often be diametrically opposite in point of temperature. Gold is common in the hottest parts of the earth, while we generally find silver mines in the cold regions. Thus, the chief parts of the world where silver is to be met with are, Sweden, Norway, and the higher latitudes near the pole: if we find it in hot climates, it is seldom on level ground, but, on the contrary, raised to a great height towards the tops of mountains that are perpetually covered with ice and snow. It is thus situated in the alpine mountains of Europe and America; and such are the mines of Allemont in France, and those of Potosi in the Andes. The principal silver mine in Europe is that of Konigsberg, in Norway, to the north of Christiana. This is the richest, the most important, and one of the most singular mines in that quarter of the globe. The district in which it is situated is mountainous; and the mines are divided into superior and inferior, on account of their relative position. The earth is composed of beds nearly in a vertical position, and running from north to south. Some are composed of quartz mixed with mica, of granite, and of chalk: while others are formed of whitish-grey quartz, mixed with fine blackish mica, or else consist of ferruginous rock. These beds are of very considerable thickness, and contain a great quantity of native as well as of mineralized silver. The veins are richer in mineral, and their produce more considerable, where they traverse the beds of ferruginous rock, than in any other part. The most remarkable mine of silver in Spain is that of Guadalcanal, in Andalusia, which was formerly very rich, and well known to the Romans. It is situated in the Sierra Morena, or black mountain, on the confines of Andalusia and Estramadura, fifteen leagues to the north of Seville, and several miles to the north-east

of the famous quicksilver mine at Ald Almaden. The mineral obtained here is the ruby silver ore. But it is in the centre of the Andes, in situations which, though immediately exposed to the perpendicular rays of the sun, are constantly covered with snow, that nature has most abundantly distributed this metal. In twenty degrees of southern latitude, within the torrid zone, we find the famous mountain of Potosi, situated near the source of the Rio de la Plata. This mountain is one of the most considerable in Peru; its height is immense; and it appears from the description of travellers, that from top to bottom it is full of veins of silver. When these mines were first discovered, in the year 1545, the veins were so rich as to be almost entirely composed of silver without any mixture. At present, however, the produce is very different, scarcely more than five drams being obtained from a hundred weight of ore; still, from the great abundance of mineral, the produce is very considerable. According to the observations of several Spanish naturalists, the mountain of Potosi alone, from the time it was first discovered, in 1545, till the year 1638, that is in the space of ninety-three years, yielded four hundred millions of pesos, or ounces of silver.

The analysis of silver ore varies according to its nature and combinations. Native silver, after being broken down and washed, is rubbed with liquid mercury, which by strong trituration dissolves and combines with the silver. This amalgam is subjected to pressure, to separate the excess of mercury. It is then distilled, and afterwards heated in a crucible, to volatilize the mercury, and the silver remains pure. When silver is combined with antimony and sulphur, the ore is to be strongly roasted, to separate the antimony or sulphur. It is then melted with a proper quantity of alkaline flux. The sulphurated oxide of silver and antimony may be treated in the same way. See Assaying.

Silver is of a fine white colour and great brilliancy. The specific gravity is 10.4, and according to some, when it is hammered, 10.5, and sometimes nearly 11. The hardness of silver is intermediate between iron and gold. The elasticity of silver is considerable, and it is one of the most sonorous of the metals. It possesses very great ductility and malleability. It may be beaten out into leaves of $\frac{1}{100000}$ of an inch thick, and a grain of silver may be so extended as to be formed into a hemispherical vessel of sufficient capacity to hold an ounce of water, or to be drawn out into a wire four hundred feet in length. The tenacity of silver is very great. A wire .078 of an inch in diameter, will support a weight of one hundred and eighty-seven pounds avoirdupois. Silver is a good conductor of caloric. Its expansive power is less than that of lead and tin, and greater than that of iron. When it is exposed to a white heat it melts. The temperature necessary to bring it to fusion has been calculated at the 1000° of Fahrenheit; but, according to Kirwan, it requires a higher temperature than 28° Wedgwood to melt it, although at that temperature it continues in a state of fusion. When it is cooled slowly after fusion, it exhibits some marks of crystallization. It assumes the form of four-sided pyramids, or of octahedrons. If the heat be increased after the silver is melted, it boils, and may be reduced to vapour. The surface of melted silver is so extremely brilliant, that it seems to throw out sparks, which is called coruscation by the workmen. Silver is a good conductor of electricity. It has no perceptible taste or smell.

Silver is not altered by exposure to the air, although it is soon tarnished, which is owing, as Proust ascertained, to a thin covering of sulphuret of silver, which is formed by sulphureous vapours to which it is exposed; but when it is subjected to a strong heat for a long time, in an open vessel, it combines with the oxygen of the atmosphere, and is converted into an oxide. In the experiments of Macquer, the oxydation of silver was effected by exposing it for twenty times successively in a crucible, to the strong heat of a porcelain furnace. At last perceptible traces of oxidation were observed, and a vitreous matter of an olive colour was obtained. In other experiments silver being acted on by the heat of a burning-glass, was covered with a white powder, which was afterwards converted into a crust of a green colour. Van Marum passed electric shocks through silver wire, which was instantly reduced to a kind of powder, with a greenish white flame, and the oxide which was formed was dissipated in vapour. The oxide of silver, which is formed by these processes, is of a greenish or yellow colour. It is composed of about ten parts of oxygen, and ninety of silver. The oxide of silver is very easily reduced, for the affinity of oxygen for this metal is very feeble. It is decomposed by the

application of heat, and even when it is exposed to the light. By heating it in close vessels, pure oxygen gas is obtained, and the metal is converted to the metallic state, by melting it in a crucible.

Silver combines with phosphorus, forming a phosphuret. One part of silver in filings, with two of phosphoric glass, and half a part of charcoal, exposed to heat in a crucible, yielded a phosphuret of silver which had acquired one fourth of its primitive weight of silver. This phosphuret is of a white colour, brittle, of a granulated texture, and may be cut with a knife. By throwing pieces of phosphorus on silver red hot in a crucible, the metal is instantly melted, and the phosphuret which is formed remains at the bottom. At the moment when the surface becomes solid, a quantity of phosphorus is thrown out with a kind of explosion, and the surface of the metal then exhibits a mamellated appearance. Pelletier, who first made this experiment, concludes from it, that silver is susceptible of retaining a greater proportion of phosphorus, in combination with it, when it is in fusion, than in the solid state, and that the separation of the phosphorus is owing to the sudden contraction of the silver. A hundred parts of silver in fusion retain twenty-five of phosphorus, but only fifteen when it becomes solid.

Phosphorus has the property of reducing the oxides of silver, and of precipitating them from this solution in acids, in the metallic form. Sulphur combines readily with silver, both in the dry and humid way. By stratifying in a crucible, plates of silver alternately with sulphur, and melting them rapidly, a deep violet-coloured mass is obtained, which is more fusible than silver, brittle, crystallized, and has a metallic lustre. It may be cut with a knife, and has a good deal of resemblance to vitreous ore of silver. When this sulphuret of silver is exposed to heat for a considerable time, the sulphur is gradually dissipated, and the silver remains pure and ductile. Silver combines very readily with sulphur, when it is long exposed to those matters which gradually deposit this substance. This effect is immediately produced when silver is brought into contact with sulphurated hydrogen gas, or when it is immersed in water impregnated with this gas, as in natural sulphureous waters. Dr. Thomson thinks it is owing to the same cause that a silver spoon is tarnished by a boiled egg, and particularly if the egg has begun to spoil. Sulphureted hydrogen gas, which is exhaled by the egg, is decomposed; the sulphur combines with the silver, and forms a thin layer of sulphuret of silver, which is of a dark or violet colour; other writers have ascribed this to the action of galvanism. The same thing happens when silver is exposed in places that are much frequented, as in churches and theatres. Silver forms alloys with most of the metals, and salts with the acids. Hence its use in coinage, and also in medicine.

Antimonial silver, in colour, is between silver white and tin white; sometimes inclining more to the one, sometimes more to the other. It occurs massive, disseminated, and crystallized. Specific gravity between 9 and 10. Heated on charcoal before the blow-pipe, the antimony is volatilized with the odour peculiar to it, and there remains a mass of silver, surrounded with a brown slag. It consists, according to Vauquelin, of

Silver	78
Antimony	22
	100

It occurs in veins which are composed of calc-spar, heavy-spar, and is accompanied with lead glance, and native silver. It is distinguished from native silver by its brittleness, and a foliated fracture.

Arsenical silver is of a tin white colour, which passes into silver white, and verges on light lead grey. It is always more or less tarnished with a blackish colour. It occurs massive, disseminated, and globular. It consists of

Arsenic	35
Iron	44.25
Silver	12.75
Antimony	7
	100

Before the blow-pipe the arsenic and antimony are volatilized, and they emit a garlike smell. The silver remains more or less pure in shape of a globule. This is a very rare mineral, and does not tarnish so quickly as native arsenic; it passes on the one side into native arsenic; on the other into native silver.

SILVERING, in the arts, consists in covering the surfaces of substances with a thin coating of silver; either for the purpose of beauty, silver being so much more handsome than the inferior metals; or, on ac-

count of its superior wholesomeness, compared with copper, brass, or lead, for culinary purposes, it resisting the corroding power of vinegar and other weak acids. The metals that are usually covered with silver, are copper and brass, and sometimes iron, and there are three distinct modes of performing the operation. 1. Silvering by amalgamation, is thus performed. to a solution of nitrated silver add some plates of copper, which will throw down the silver in its metallic state, and very finely divided; scrape it from the surface of the copper, wash it well and dry it. Of this powder take half an ounce, of common salt and sal ammoniac two ounces, and of corrosive sublimate one drachm, rub them well together, and make them into a paste with a little water Then take the vessel to be silvered, and clean it by means of a little very dilute aquafortis, or by scouring it with a mixture of common salt and tartar. When it is perfectly clean, rub it with the above-mentioned paste till it is entirely covered with a white metallic coating, this coating is an amalgam produced by the decomposition of the corrosive sublimate, by means of the copper, to the surface of which it applies very closely and expeditiously. The copper being thus silvered over, is to be washed, dried, and afterwards heated nearly red, in order to drive off the mercury; the silver remains behind, adhering firmly to the copper, and capable of being highly polished. 2. Silvering by luna cornea. Prepare the luna cornea in the usual manner, by pouring a solution of common salt into nitrate of silver, as long as any precipitation takes place, and boiling the mixture, the white curdy matter, thus obtained, is to be mixed with three parts of good pearl-ash, one part of washed whiting, and somewhat more than one part of common salt. The surface of the brass being cleared from scratches, is to be rubbed with a piece of old hat and rotten stone, to remove any grease, and then is to be moistened with salt and water; a little of the composition being now rubbed on with the finger, the surface of the metal will presently be covered with silver. Then wash it well, rub it dry with soft rag, and, as the coat of silver is extremely thin, cover it with transparent varnish, to preserve it from tarnish. This kind of silvering is very imperfect, and is only used for the faces of clocks, the scales of barometers, and similar objects. 3. Silvering by silver in substance. There are three ways of performing this. The first is, by mixing together twenty grains of silver, precipitated by copper, two drachms of tartar, two drachms of common salt, and half a drachm of alum, this composition being rubbed on a perfectly clean surface of copper or brass, will cover it with a thin coating of silver, which may afterwards be polished with a piece of soft leather. A still better way is that which is called French plating, which consists in burnishing down upon the surface of the copper successive layers of leaf-silver to any required thickness. In this the silver has much more solidity than in any of the former, but the process is tedious, and the junctures of the leaves of silver cannot always be entirely concealed. The English method of plating (in those works to which it is applicable) appears to be the best of all. It is thus performed: one of the surfaces of an ingot of copper is rendered quite smooth and clean, and is sprinkled over with glass of borax, upon this is laid a plate of fine silver, about one-twelfth of the weight of the copper, and the two are carefully bound together by wire; the mass is now exposed to a full red heat, which melts the borax, and causes the silver to adhere to the copper; the ingot is now passed through a rolling press, and formed into a plate; both the silver and copper extending uniformly during the whole process, at the conclusion of which, the two metals are inseparably fixed to each other. See Aikin's "Dictionary."

SILURUS, the *silure*, in natural history, a genus of fishes of the order Abdominales. Generic character: head large, naked, and depressed, mouth extremely wide, and furnished with long feelers or tentacula, eyes small, body lengthened, naked; first ray of the pectoral or dorsal fin, serrated with reversed spines. There are twenty-nine species, of which the following most deserve notice.

S. glanis is generally about three feet long, though it has been seen of twelve, and of the weight of three hundred pounds, and consequently is one of the very largest of European river fishes. It is most plentiful in the north, is seldom seen in motion, and commonly lies ingulfed in mud at the bottoms, with its mouth open, and its long tentacula moving about in every direction. These last being similar in appearance to worms, are mistaken for such by many fishes, which are, by this deception, drawn within the jaws of destruction. Its flesh is used for its cheapness, rather than its ex-

cellence; and its skin, by some simple process, is converted into a hard, transparent substance, which accomplishes the purposes of horn and glass.

SIMIA, the *ape*, in natural history, a genus of Mammalia, of the order Primates. Generic character: front teeth in each jaw four, near together, canine teeth solitary, longer than the others, distant from the grinders; grinders obtuse. Animals of this genus are commonly divided into such as have no tails; such as have only very short ones, such as have very long ones; and, lastly, such as have prehensile tails, with which they can lay hold of any object at pleasure. These four classes are called respectively apes, baboons, monkeys, and japajous. In the whole genus there are enumerated by Gmelin sixty-three species, of which we shall notice some of the most important.

S. satyrus, or the orang-outang. This animal is said to grow in its native woods of Africa and India to the height of six feet, and to subsist, like most other species, on fruits. It flies from the haunts of mankind, leads a solitary life, and displays great strength, agility, and swiftness, which render it extremely difficult to be taken. It has been known to attack and destroy negroes, wandering at a distance from their habitations, and to carry off women to its wretched habitation, watching them with such extraordinary vigilance, as scarcely to admit the possibility of their escape. Its general resemblance to the human figure and countenance is particularly and mortifyingly strong, yet minute observation and dissection have pointed almost innumerable differences, the detail of which is here impossible. It is capable of being tamed and domesticated, and, many years since, one was exhibited in London which had been disciplined to sit, and work, and eat, like a human being, using a knife and fork for the latter purpose. Its disposition was pensive; its manners were gentle, and it appeared to possess, for its keepers, and those to whom it had been long familiarized, a high degree of genuine gratitude and attachment. For the orang-outang, see Mammalia, Plate XIX. fig. 1.

S. inuus, the Barbary ape, is about four feet in height, and is the species most commonly exhibited in public shows, and is trained to the performance of a great variety of tricks, calculated to attract popular admiration. The discipline it passes through is often severe, and this species is considered, in its natural state, as being more ferocious, and less sagacious, than several others of the class. See Mammalia, Plate XIX. fig. 2.

S. sphynx, or the great baboon, is between three and four feet high, of a grey-brown colour, and is particularly muscular in the upper part of its body, its hands and feet have sharp nails, like claws, but on its thumbs there are nails formed like those on the human fingers. It is an animal incapable of domestication, and has, in no instance, been observed to be divested of great malignity and fierceness of disposition. The female produces only one young one at a birth, which she suckles at her breast, and carries about with her in her arms. Baboons inhabit the hottest climates of Africa, and are often seen in very considerable numbers. The plantations of fruits and roots are frequently much injured by their depredations. They are scarcely, in any species, susceptible of attachment. In confinement, they display incessant restlessness and irritation, and in their form and manners they present a complication of ferocity and hideousness. See Mammalia, Plate XIX. fig. 3.

S. hamadryas, or the dog-faced baboon, is very large, and often greater than the common baboon. It is distinguished by a vast quantity of hair, spreading from each side of the head down the shoulders, and covering the animal to the waist, like a mantle. Its colour is a mixture of grey and brown. It is a ferocious and dangerous animal, is found in the most torrid regions of Africa, and, though more rare than the common species, is yet seen occasionally in large companies. Its general aspect, when in an undisturbed state, is that of profound meditation; but when molested, its looks indicate the most perturbed and malignant feelings. In confinement, it is turbulent, untractable, and filthy. The tail of this baboon is nearly as long as its body.

S. leonina, or the leonine monkey, is supposed to be an inhabitant of Abyssinia, and is two feet in length, from the nose to the tail; along the face is a great quantity of long hair, extending nearly from the eyes back over the forehead and crown of the head, and from the chin over the neck, and this bushment of hair gives it, in addition to the general form and countenance of the animal, no slight resemblance to the lion, from which it derives its designation. See Mammalia, Plate XIX. fig. 4.

S. mona, or the varied monkey, is one of

the largest species, and is nearly two feet in length. It is found in various parts of Africa, and differs much in individuals in respect to colours, which are sometimes bright, and at others dull. In general it is of a dark olive-grey. See Mammalia, Plate XIX. fig. 5.

S. nasalis, or the proboscis monkey, is one of the most curious in its aspect, and most ludicrous of the class. It is about two feet in length. The face is of an incurvated form, and of a brown colour, and the nose, which is its great singularity, is of such a length and shape, as to give the animal an appearance highly grotesque. By a groove or furrow running down it, from the beginning to the tip, it is nearly divided into two lobes, and, on a side view, its extreme projection is nearly as striking and singular, as the former circumstance renders a full one. It is found in the East Indies, where, however, it is somewhat rare. It is said to be more numerous in Cochin China. It feeds on fruits, and is highly untractable and savage.

S. beelzebul, or, the preacher monkey, is as large as a fox, and is extremely common in the woods of Brasil. Travellers have stated, that it is usual for one of these to ascend a tree, and, by certain sounds, to collect vast multitudes beneath him, when he commences a howl so loud as to be heard to a vast distance. After this has continued for some time, he, by a particular signal, induces those around him to join in the noise, which then becomes most hideous and intolerable. This united clamour at length ceases, and the original howler again proceeds undisturbed in his address. The throat-bone of this monkey appears, from dissection, to be particularly constructed for the utterance of strong sounds.

The S. seniculus, or royal monkey, is about the size of a squirrel, and inhabits the damp, woody districts of Cayenne, being never found on the mountains. In its sounds and manners, it resembles the last species. In the morning and evening, and sometimes on several occasions in the interval, these animals produce such rattling, terrific, and varied noises, as excite the idea of every native of the forest being in open cry. And even the sounds of a single one are so powerful, as to impress the idea of peril very strongly on the hearer. These creatures are extremely tenacious of life. They will often sustain parts of several discharges from guns, before they drop from the tree, which they cling to with the last efforts of existence, sometimes, indeed, maintaining their hold, it is said, by the hands and tail, even after death. The two last species belong to the class of monkeys with prehensile tails, or japajous. The greater number of the animals of this comprehensive genus are said to be remarkably fond of snuff, mustard, and tobacco, which they will eat in considerable quantities. A great number of species are furnished with cheek-bags, or pouches, where they may deposit, for the convenience of carriage, a supply of food, which will last for several days after they have finished their immediate repast. Monkeys are, in some parts of Africa, used for food, and several species are said to be excellent and delicate for this purpose.

SIMILAR, in arithmetic and geometry, the same with like. Those things are said to be similar or like, which cannot be distinguished but by their compresence, that is, either by immediately applying the one to the other, or some other third to them both, so tha there is nothing found in one of the similar things but is equally found in the other, notwithstanding their similitude may differ in quantity; and since, in similar things, there is nothing wherein they differ besides the quantity: quantity itself is the internal difference of similar things. In mathematics, similar parts have the same ratio to their wholes, and if the wholes have the same ratio to the parts, the parts are similar. See PART.

Similar angles are also equal angles. In solid angles, when the planes under which they are contained are equal, both in number and magnitude, and are disposed in the same order, they are similar, and consequently equal. Similar arches of a circle are such as are like parts of their whole circumferences, and consequently equal. Similar plane numbers, are those numbers which may be ranged into the form of similar rectangles, that is, into rectangles whose sides are proportional; such are 12 and 48, for the sides of 12 are 6 and 2, and the sides of 48 are 12 and 4; but 6 : 2 :: 12 : 4, and therefore those numbers are similar. Similar polygons are such as have their angles severally equal, and the sides about those angles proportional. Similar rectangles are those which have their sides about the equal angles proportional: hence, 1. All squares are similar rectangles. 2. All similar rectangles are to each other as the squares of their homologous sides. Similar right-lined

figures are such as have equal angles, and the sides about those equal angles proportional. Similar segments of a circle are such as contain equal angles. Similar curves: two segments of two curves are called similar, if, any right lined figure being inscribed within one of them, we can inscribe always a similar right-lined figure in the other. Similar conic sections: two conic sections are said to be similar, when any segment being taken in the one, we can assign always a similar segment in the other. Similar diameters of two conic sections: the diameters in two conic sections are said to be similar, when they make the same angles with their ordinates. Similar solids are such as are contained under equal numbers of similar planes, alike situated. Similar triangles are such as have their three angles respectively equal to one another: hence, 1. All similar triangles have the sides about their angles proportional. 2. All similar triangles are to one another as the squares of their homologous sides.

SIMILAR *bodies*, in natural philosophy, are such as have their particles of the same kind and nature with one another.

SIMILAR *figures*, in geometry, such as have their angles respectively equal, and the sides, about the equal angles, proportional.

SIMILAR *parts*, in anatomy, are those parts of the body which at first sight appear to consist of like parts, or parts of the same nature, texture, and conformation; of these we usually reckon ten, *viz.* the bones, cartilages, ligaments, membranes, fibres, nerves, arteries, veins, flesh, and skin.

SIMILE, or SIMILITUDE, in rhetoric, a comparison of two things, which, though different in other respects, yet agree in some one. The difference between a simile and comparison, is said to consist in this, that the simile properly belongs to whatever we call the quality of the thing, and the comparison to the quantity.

SIMILITUDE, in arithmetic, geometry, &c. denotes the relation of two things similar to each other.

SIMONY, is the corrupt presentation of any one to an ecclesiastical benefice, for money, gift, reward, or benefit. It was not an offence punishable criminally at the common law, it being thought sufficient to leave the clerk to ecclesiastical censures. But as these did not affect the simoniacal patron, none were efficacious enough to repel the notorious practice of the thing. Several acts of parliament have, therefore, been made to restrain it, by means of civil forfeitures, which the modern prevailing usage with regard to spiritual preferments call aloud to put in execution.

By one of the canons of 1603, every person, before his admission to any ecclesiastical promotion, shall, before the ordinary, take an oath, that he hath made no simoniacal contract, promise, or payment, directly or indirectly, by himself or any other, for the obtaining of the said promotion; and that he will not afterwards perform or satisfy any such kind of payment, contract, or promise, by any other without his knowledge or consent.

To purchase a presentation, the living being actually vacant, is open and notorious simony; this being expressly in the face of the statute. But the sale of an advowson during a vacancy is not within the statute of simony, as the sale of the next presentation is; but it is void by the common law.

A bond of resignation is a bond given by the person intended to be presented to a benefice, with condition to resign the same; and is special or general. The condition of a special one is, to resign the benefice in favour of some certain person, as a son, kinsman, or friend of the patron, when he shall be capable of taking the same. By a general bond, the incumbent is bound to resign on the request of the patron. A bond, with condition to resign within three months after being requested, to the intent that the patron might present his son when he should be capable, was held good; and the judgment was affirmed in the exchequer-chamber: for that a man may, without any colour of simony, bind himself for good reasons; as if he take a second benefice, or if he be non-resident, or that the patron present his son, to resign; but if the condition had been to let the patron have a lease of the glebe or tithes, or to pay a sum of money, it had been simoniacal.

SIMOOM. A wind or haze was observed by Mr. Bruce, in the course of his travels to discover the sources of the Nile, which is supposed to be in some respects analogous to the sirocco. It is called by him the simoom, and from its effects upon the lungs, we can entertain but little doubt, that it consists chiefly of carbonic acid gas in a very dense state, and perhaps mixed with some other noxious exhalations.

Mr. Bruce, who, in his journey through the desart, felt the effects of the simoom, gives of it the following graphical description: " At eleven o'clock, while we con-

templated with great pleasure the rugged top of Chiggre, to which we were fast approaching, and where we were to solace ourselves with plenty of good water, Idris, our guide, cried out, with a loud voice, fall upon your faces, for here is the simoom. I saw from the south-east a haze coming, in colour like the purple part of the rainbow, but not so compressed or thick. It did not occupy twenty yards in breadth, and was about twelve feet high from the ground. It was a kind of blush upon the air, and it moved very rapidly, for I scarce could turn to fall upon the ground with my head to the northward, when I felt the heat of its current plainly upon my face. We all lay flat on the ground as if dead, till Idris told us it was blown over. The meteor or purple haze which I saw was indeed passed, but the light air that still blew was of heat to threaten suffocation. For my part, I found distinctly in my breast that I had imbibed a part of it, nor was I free from an asthmatic sensation till I had been some months in Italy, at the baths of Poretta, near two years afterwards." Though the severity of this blast seems to have passed over them almost instantaneously, it continued to blow so as to exhaust them till twenty minutes before five in the afternoon, lasting through all its stages very nearly six hours, and leaving them in a state of the utmost despondency.

SIMPLE, something not mixed or compounded, in which sense it stands opposed to compound.

SIMPLE, in pharmacy, a general name given to all herbs or plants, as having each its particular virtue, whereby it becomes a simple remedy.

SIMPLE *Contract*, in law, debts by simple contract, are such where the contract upon which the obligation arises is neither ascertained by matter of record, nor yet by special deed or instrument, but by mere oral evidence, or by notes unsealed; whereas debts by speciality are such whereby the contract is ascertained by deed or instrument, under seal. Simple contract debts are to be paid by executors after debts by speciality.

SIMPSON (THOMAS), in biography, professor of mathematics at the Royal Academy at Woolwich, fellow of the Royal Society, and member of the Royal Academy, at Stockholm, was born at Market Bosworth, in Leicestershire, in 1710. His father, a stuff-weaver, taught him only to read English, and brought him up to his own business; but meeting with a scientific pedlar, who also practised fortune-telling, young Simpson, by his assistance and advice, left off weaving, and professed astrology. As he improved in knowledge, however, he grew disgusted with his pretended art, and, renouncing it, was driven to such difficulties for the subsistence of his family, that he came up to London, where he worked as a weaver, and taught mathematics at his spare hours. As his scholars increased, his abilities became better known, and he published his Treatise on Fluxions, by subscription, in 1737, in 1740 he published his Treatise on the Nature and Laws of Chance, and Essay in Speculative and Mixed Mathematics. After these appeared his Doctrine of Annuities and Reversions; Mathematical Dissertations; Treatise on Algebra; Elements of Geometry; Trigonometry, Plane, and Spherical; Select Exercise; and his Doctrine and Application of Fluxions, which he professes to be rather a new work, than a second edition of his former publication on fluxions. In 1743, he obtained the mathematical professorship at Woolwich Academy, and soon after was chosen a member of the Royal Society, when the president and council, in consideration of his moderate circumstances, were pleased to excuse his admission-fees, and his giving bonds for the settled future payments. At the academy he exerted all his abilities in instructing the pupils, who were the immediate objects of his duty, as well as others whom the superior officers of the ordnance permitted to be boarded and lodged in his house. In his manner of teaching he had a peculiar and happy address, a certain dignity and perspicuity, tempered with such a degree of mildness, as engaged the attention, esteem, and friendship, of his scholars. He therefore acquired great applause from his superiors in the discharge of his duty.

Mr. Simpson's Miscellaneous Tracts, printed in 4to., 1757, were his last legacy to the public: a most valuable bequest, whether we consider the dignity and importance of the subjects, or his sublime and accurate manner of treating them.

The first of these papers is concerned in determining the Precession of the Equinox, and the different Motions of the Earth's Axis, arising from the Attraction of the Sun and Moon. It was drawn up about the year 1752, in consequence of another on the same subject, by M. de Sylvabelle, a French gentleman. Though this gentleman had gone through one part of the sub-

ject with success and perspicuity, and his conclusions were perfectly conformable to Dr. Bradley's observations, it nevertheless appeared to Mr. Simpson, that he had greatly failed in a very material part, and that indeed the only very difficult one; that is, in the determination of the momentary alteration of the position of the Earth's axis, caused by the forces of the Sun and Moon; of which forces, the quantities, but not the effects, are truly investigated. The second paper contains the Investigation of a very exact Method or Rule for finding the Place of a Planet in its Orbit, from a Correction of Bishop Ward's circular Hypothesis, by Means of certain Equations applied to the Motion about the upper Focus of the Ellipse. By this method the result, even in the orbit of Mercury, may be found within a second of the truth, and that without repeating the operation. The third shows the Manner of transferring the Motion of a Comet from a parabolic Orbit, to an elliptic One; being of great use, when the observed places of a (new) comet are found to differ sensibly from those computed on the Hypothesis of a parabolic orbit. The fourth is an Attempt to show, from Mathematical Principles, the Advantage arising from taking the Mean of a Number of Observations, in practical Astronomy; wherein the odds, that the result in this way is more exact than from one single observation, is evinced, and the utility of the method in practice clearly made appear. The fifth contains the Determination of certain Fluents, and the Resolution of some very useful Equations, in the higher Orders of Fluxions, by means of the measures of angles and ratios, and the right and versed sines of circular arcs. The sixth treats of the Resolution of algebraical Equations, by the Method of Surd-divisors; in which the grounds of that method, as laid down by Sir Isaac Newton, are investigated and explained. The seventh exhibits the Investigation of a general Rule for the Resolution of Isoperimetrical Problems of all Orders, with some examples of the use and application of the said rule. The eighth, or last part, comprehends the Resolution of some general and very important Problems in Mechanics and Physical Astronomy; in which, among other things, the principal parts of the third and ninth sections of the first book of Newton's Principia are demonstrated in a new and concise manner. But what may perhaps best recommend this excellent tract, is the application of the general equations, thus derived, to the determination of the lunar orbit.

According to what Mr. Simpson had intimated at the conclusion of his Doctrin of Fluxions, the greatest part of this arduous undertaking was drawn up in the year 1750. About that time M. Clairaut, a very eminent mathematician of the French academy, had started an objection against Newton's general law of gravitation. This was a motive to induce Mr. Simpson (among some others) to endeavour to discover whether the motion of the Moon's apogee, on which that objection had its whole weight and foundation, could not be truly accounted for, without supposing a change in the received law of gravitation, from the inverse ratio of the squares of the distances. The success answered his hopes, and induced him to look further into other parts of the theory of the Moon's motion than he at first intended: but before he had completed his design, M. Clairaut arrived in England, and made Mr. Simpson a visit; from whom he learned, that he had a little before printed a piece on that subject, a copy of which Mr. Simpson afterwards received as a present, and found in it the same things demonstrated, to which he himself had directed his enquiry, besides several others.

The facility of the method Mr. Simpson fell upon, and the extensiveness of it, will in some measure appear from this, that it not only determines the motion of the apogee in the same manner, and with the same ease, as the other equations, but utterly excludes all those dangerous kind of terms that had embarrassed the greatest mathematicians, and would, after a great number of revolutions, entirely change the figure of the Moon's orbit. From whence this important consequence is derived, that the Moon's mean motion, and the greatest quantities of the several equations, will remain unchanged, unless disturbed by the intervention of some foreign or accidental cause. These tracts are inscribed to the Earl of Macclesfield, President of the Royal Society.

Mr. Simpson's extreme application in this difficult pursuit greatly injured his health. Exercise and a proper regimen were prescribed to him, but to little purpose; for his spirits sunk gradually, till he became incapable of performing his duty, or even of reading the letters of his friends. The effects of this decay of nature were greatly increased by vexation of mind, owing to the haughty and insulting behaviour of his supe-

rior, the first professor of mathematics. This person, greatly his inferior in mathematical accomplishments, did what he could to make his situation uneasy, and even to depreciate him in the public opinion; but it was a vain endeavour, and only served to injure himself. At length his physicians advised his native air for his recovery, and he set out in February, 1761; but was so fatigued by his journey, that upon his arrival at Bosworth, he betook himself to his chamber, and grew continually worse till the day of his death, which happened on the 14th of May, in the 51st year of his age.

SIMSON (Dr. Robert), in biography, professor of mathematics in the university of Glasgow, was born in the year 1687 of a respectable family, which had held a small estate in the county of Lanark for some generations. He was, we think, the second son of the family. A younger brother was professor of medicine in the university of St. Andrew's, and is known by some works of reputation, particularly "A Dissertation on the Nervous System," occasioned by the dissection of a brain completely ossified.

Dr. Simson was educated in the university of Glasgow under the eye of some of his relations who were professors. Eager after knowledge, he made great progress in all his studies; and as his mind did not, at the very first openings of science, strike into that path which afterwards so strongly attracted him, and in which he proceeded so far almost without a companion, he acquired in every walk of science a stock of information, which, though it had never been much augmented afterwards, would have done credit to a professional man in any of his studies. He became, at a very early period, an adept in the philosophy and theology of the schools, was able to supply the place of a sick relation in the class of oriental languages, was noted for historical knowledge, and one of the most knowing botanists of his time. As a relief to other studies, he turned his attention to mathematics. Perspicuity and elegance he thought were more attainable, and more discernible in pure geometry, than in any other branch of the science. To this therefore he chiefly devoted himself; for the same reason he preferred the ancient method of studying pure geometry. He considered algebraic analysis as little better than a kind of mechanical knack, in which we proceed without ideas, and obtain a result without meaning, and without being conscious of any process of reasoning, and therefore without any conviction of its truth. Such was the ground of the strong bias of Dr. Simson's mind to the analysis of the ancient geometers. It increased as he advanced, and his veneration for the ancient geometry was carried to a degree of idolatry. His chief labours were exerted in efforts to restore the works of the ancient geometers. The inventions of fluxions and logarithms attracted the notice of Dr Simson, but he has contented himself with demonstrating their truth on the genuine principles of ancient geometry.

About the age of twenty-five, Dr. Simson was chosen Regius Professor of Mathematics in the university of Glasgow. He went to London immediately after his appointment, and there formed an acquaintance with the most eminent men of that bright era of British science. Among these he always mentioned Captain Halley (the celebrated Dr. Edmund Halley) with particular respect; saying, that he had the most acute penetration, and the most just taste in that science, of any man he had ever known. And, indeed, Dr. Halley has strongly exemplified both of these in his divination of the work of "Apollonius de Sectione Spatii," and the eighth book of his "Conics," and in some of the most beautiful theorems of Sir Isaac Newton's "Principia." Dr. Simson also admired the wide and masterly steps which Newton was accustomed to take in his investigations, and his manner of substituting geometrical figures for the quantities which are observed in the phenomena of nature. It was from Dr. Simson that his biographer, to whom we are indebted for this article, learnt, "That the thirty-ninth proposition of the first book of the Principia was the most important proposition that had ever been exhibited to the physico-mathematical philosopher;" and he used always to illustrate to his more advanced scholars the superiority of the geometrical over the algebraic analysis, by comparing the solution given by Newton of the inverse problem of centripetal forces, in the forty-second proposition of that book, with the one given by John Bernoulli in the Memoirs of the Academy of Sciences at Paris for 1713. He had heard him say, that to his own knowledge Newton frequently investigated his propositions in the symbolical way; and that it was owing chiefly to Dr. Halley that they did not finally appear in that dress. But if Dr. Simson was well informed, we think it a

great argument in favour of the symbolic analysis when this most successful practical artist (for so we must call Newton when engaged in a task of discovery) found it conducive either to dispatch or perhaps to his very progress. Returning to his academical chair, Dr. Simson discharged the duties of a professor for more than fifty years with great honour to the university and to himself. It is almost needless to say, that in his prelections he followed strictly the Euclidian method in elementary geometry. He made use of Theodosius as an introduction to spherical trigonometry. In the higher geometry he lectured from his own Conics, and he gave a small specimen of the linear problems of the ancients, by explaining the properties, sometimes of the conchoid, sometimes of the cissoid, with their application to the solution of such problems. In the more advanced class he was accustomed to give Napier's mode of conceiving logarithms, *i. e.* quantities as generated by motion, and Mr. Cotes's view of them, as the sums of ratiunculæ, and to demonstrate Newton's lemmas concerning the limits of ratios, and then to give the elements of the fluxionary calculus; and to finish his course with a select set of propositions in optics, gnomonics, and central forces. His method of teaching was simple and perspicuous, his elocution clear, and his manner easy and impressive. He had the respect, and still more the affection, of his scholars.

It was chiefly owing to the celebrated Halley that Dr. Simson so early directed his efforts to the restoration of the ancient geometers. He had recommended this to him, as the most certain way for him, at that time very young, both to acquire reputation, and to improve his own knowledge and taste, and he presented him with a copy of Pappus's Mathematical collections, enriched with his own notes. Hence he undertook the restoration of Euclid's porisms, a work of some difficulty, that his biographer says nothing but success could justify in so young an adventurer. From this he proceeded to other works of importance, which he executed with so much skill, as to obtain the reputation of being one of the most elegant geometers of the age. His edition of Euclid's "Elements" has long been reckoned the very best that exists. Another work, on which Dr. Simson bestowed much labour, was the "Sectio determinata," which was published after his death, by the late Earl Stanhope, with the great work, "The Porisms of Euclid." This nobleman had kept up a correspondence with Dr Simson till his death in 1768, when he engaged Mr. Clow, to whose care the Doctor had left his papers, to make a selection of such as would serve to support and increase his reputation, as the restorer of ancient geometry. This selection Lord Stanhope printed at his own expense.

"The life of a literary man rarely teems with anecdote; and a mathematician, devoted to his studies, is perhaps more abstracted than any other person from the ordinary occurrences of life, and even the ordinary topics of conversation. Dr. Simson was of this class, and, having never married, lived entirely a college life. Having no occasion for the commodious house to which his place in the university intitled him, he contented himself with chambers, good indeed, and spacious enough for his sober accommodation, and for receiving his choice collection of mathematical writers, but without any decoration or commodious furniture. His official servant sufficed for valet, footman, and chambermaid. As this retirement was entirely devoted to study, he entertained no company in his chambers, but in a neighbouring house, where his apartment was sacred to him and his guests. Having in early life devoted himself to the restoration of the works of the ancient geometers, he studied them with unremitting attention, and retiring from the promiscuous intercourse of the world, he contented himself with a small society of intimate friends, with whom he could lay aside every restraint of ceremony or reserve, and indulge in all the innocent frivolities of life. Every Friday evening was spent in a party at whist, in which he excelled, and took delight in instructing others, till increasing years made him less patient with the dullness of a scholar. The card party was followed by an hour or two, dedicated solely to playful conversation. In like manner, every Saturday he had a less select party to dinner at a house about a mile from town. The Doctor's long life gave him occasion to see the dramatis personæ of this little theatre several times completely changed, while he continued to give it a personal identity; so that, without any design or wish of his own, it became, as it were, his own house and his own family, and went by his name. Dr. Simson was of an advantageous stature, with a fine countenance; and even in his old age had a graceful carriage and manner, and always, except when

rier, the first professor of mathematics. This person, greatly his inferior in mathematical accomplishments, did what h[illegible] to make his situation uneasy. [illegible] depreciate him in the p[illegible] it was a vain endea[illegible] injure himself. A[illegible] advised his nativ[illegible] he set out in Fe[illegible] tigued by his [illegible] at Boswor[illegible] ber, and [illegible] day of [illegible] 14th [illegible]

SI[illegible] pro[illegible] of [illegible] r [illegible] ... It is considered as the [illegible] choice collection of mathematical [illegible] and manuscripts in the kingdom, and many of them are rendered doubly valuable by [illegible] notes." For a more [illegible] account of the life and writings of [illegible] great man, the reader is referred to the [illegible] in the Encyclopedia Britannica.

SINAPIS, in botany, mustard, or charlock; a genus of the Tetradynamia Siliquosa class and order. Natural order of Siliquosæ or Cruciformes. Cruciferæ, Jussieu. Essential character: calyx spreading; corolla claws erect; gland between the shorter stamens and pistil, and between the longer stamens and calyx. There are nineteen species.

SINE, or right SINE of an arch, in trigonometry, is a right line drawn from one end of that arch, perpendicular to the radius drawn to the other end of the arch; being always equal to half the chord of twice the arch. See TRIGONOMETRY.

SINECURES, ecclesiastical benefices without cure of souls. No church, where there is but one incumbent, can properly be a sinecure: and though the church being down, or the parish being become destitute of parishioners, the incumbent may be thereby necessarily acquitted from the actual performance of public duty; yet he is still under an obligation to do it whenever a church shall be built, and there are a competent number of inhabitants: and in the mean time, if the church be presentative, as most such churches are, the incumbent is instituted into the care of souls; such benefices are rather depopulations than sinecures, and it will be proper for the new incumbent to read the thirty-nine articles, and the liturgy in the church-yard, &c. and to do whatever other incumbents usually do. But a rectory, or portion of it, may proper-[illegible] a vicar under [illegible] charged with the [illegible] does not come within [illegible] 21 Henry VIII. [illegible] therefore, no dispensation is [illegible] hold the sinecure with a former [illegible] need the incumbent read the [illegible] or divine service, as required by [illegible] Elizabeth, c. 12, which extends only to [illegible] benefices with cure. By the above-mentioned statute of Henry VIII. not only prebends and rectories, with vicarages endowed, but deaneries, and arch deaneries, are declared to be benefices without cure.

SINGING, the art of producing with the voice the sounds of any melody, together with the words to which that melody is set. To perform this with justness and good effect, a fine voice, sensible ear, great natural taste, and a knowledge in the science of music, are indispensable requisites.

SINGULAR *number*, in grammar, that number of nouns and verbs which stands opposed to plural; and is used when we only speak of a single, or one, person, or thing.

SINISTER, in heraldry. The sinister side of an escutcheon is the left hand side; the sinister chief, the left angle of the chief, the sinister base, the left hand part of the base.

SINKING FUND, a portion of the public revenue set apart to be applied to the reduction or discharge of the public debts. The appropriation of a part of the revenue to this purpose is a measure which had been adopted in other countries, long before any necessity for it existed in England, a provision of this kind having been established in Holland in 1655, and in the Ecclesiastical State in 1685. Both these funds originated in a reduction of the interest payable on the public debts, which was the means afterwards adopted for the establishment of a similar fund in this country.

At the commencement of the funding system, the loans were chiefly raised on terminable annuities, which are in themselves a species of sinking fund, but when the present mode of borrowing on perpetual annuities was preferred, it soon became evident that a continual accumulation of public debts would in time involve the government in much embarassment, if it was not attended with still worse consequences. Various projects were therefore offered for the discharge of the public debts, or for

confining them within moderate bounds; and among others, the plan of such a sinking fund as was afterwards actually established was clearly laid down in a pamphlet, entitled, "A Letter to a Member of the late Parliament, concerning the Debts of the Nation," published in 1701. In 1713, Mr. A. Hutcheson presented to the King a plan for payment of the public debts. In 1715, different projects for this purpose were published by Edward Leigh, Mr. Asgill, and others. And, in 1716, a plan for the gradual discharge of the debt was actually adopted, which was afterwards generally known by the appellation of the sinking fund. Sir Robert Walpole claimed great merit as the father of this fund, though it certainly required very little knowledge or invention to copy a plan which had been found successful in other countries, and which had been publicly recommended many years before; but whatever claims Sir R. Walpole might have to the formation of the plan, he indisputably has all the disgrace of having perverted and destroyed it. The act by which it was established was worded as strong as possible, and expressly ordained, that the fund should be applied to the discharge of the public debts, and to no other use or purpose whatsoever; but, in 1722, it was made a collateral security for the interest of a million raised on exchequer bills, which prepared the way for more direct encroachments. In 1724, a sum was taken from the fund to make good the loss to the treasury from the reduction of the value of gold coin; and in 1727 the whole produce of the civil list revenues were settled on the King, by which the sinking fund was deprived of about 100,000*l.* per annum, to which the surplus of these revenues had usually amounted. In 1733 the gross sum of half a million was taken from the fund towards the current supplies, at which time the medium annual produce of the fund for five years had been 1,212,000; but the alienation of it being continued by charging it with the interest of new loans, taking sums from it towards the supplies, and even anticipating its produce, little progress was made in the reduction of the debt, and at length the sinking fund became a mere nominal distinction.

The ruinous tendency of a continual accumulation of public debts was strongly pointed out by various writers on subjects of policy and finance; but by none with more zeal and ability than the late Dr. Price, who, about the year 1769, offered to the public some observations on the national debt, in the third chapter of his "Observations on Reversionary Payments," in which he particularly recommended the establishment of a permanent sinking fund, on the principle of that established by Sir Robert Walpole, but of which the efficacy had been so soon destroyed. In 1771, in an "Appeal to the Public on the Subject of the National Debt," he showed that the best scheme for paying off the debt, was that which had long been known, which had been adopted, but unhappily crushed in its infancy; and in 1773, in the preface to the third edition of his "Treatise on Reversionary Payments," he took the opportunity of again enforcing the necessity of restoring the plan formerly established, and securing it from future perversion. This advice was repeatedly urged on subsequent occasions; and in 1785, when Mr. Pitt was deliberating on the best means of establishing a new sinking fund, he particularly sought the advice and assistance of Dr. Price, who communicated three plans, which appeared to him the best adapted for carrying into execution a measure he had so long and so earnestly recommended. It was one of the three plans thus communicated which was afterwards adopted; but with some alterations which considerably affected its efficacy, and which it has since been found necessary to correct.

By the act passed in 1786, for establishing the new sinking fund, the annual sum of one million was placed in the hands of commissioners, who are, the Speaker of the House of Commons, the Chancellor of the Exchequer, the Master of the Rolls, the Accomptant General of the Court of Chancery, and the Governor and Deputy Governor of the Bank of England for the time being respectively. This million was to be issued in four equal quarterly payments, and to be applied either in paying off such redeemable annuities as shall be at or above par, in such manner as may be directed by future acts of parliament, or in the purchase of annuities below par at the market price. The dividends on the sums redeemed or purchased, with the annuities for lives or terms of years that fall in or expire, and the sums which may be saved by any reduction of interest, were to be added to the fund, which, according to the original act, was to continue thus increasing till it amounted to four millions per annum; which it was then computed would be about the year 1812, when upwards of fifty-six millions of stock would be redeemed. From this time the dividends on such capital as should in future be paid off or purchased by the commis-

sioners, with such annuities as might afterwards fall in, were to be at the disposal of Parliament.

The commissioners were directed by the act to make their purchases "in equal portions, as nearly as may be, on every day (Saturdays and Mondays excepted) on which the same shall be transferrable." They were empowered to subscribe towards any public loan, to be raised by act of Parliament, upon perpetual annuities, subject to redemption at par; and an account of the sums issued to them, and of the stock purchased to the first of February in every year, was directed to be annually laid before Parliament, on or before the 15th of February. The purchases at first were all made in the 3 per cents, probably with the view of redeeming the 5 per cents, if the state of the public funds should render such a measure practicable, or of inducing the proprietors to agree to a reduction of the interest at the time when they would become redeemable.

On the 17th February, 1792, the minister proposed, for the purpose of accelerating the operation of the fund, that the sum of 400,000*l.* should be issued in addition to the annual million; and stated, that, in consequence of this and future intended additions, it might be expected that twenty-five millions of 3 per cents, would be paid off by the year 1800: and that in the year 1808 the fund would have arisen to four millions per annum, being the sum to which it was restricted by the original act. The accumulation, however, was not to cease till the interest of the capital discharged, and the amount of expired annuities, should, together with the annual million only, and exclusive of the proposed additions, amount to four millions. But the most important improvement was a provision, that, whenever in future any sums shall be raised by loans, on perpetual redeemable annuities, a sum, equal to one per cent. on the stock created by such loans, should be issued out of the produce of the consolidated fund quarterly, to be placed to the account of the commissioners; and if the loan, or any part, is raised by annuities, for a longer term than forty-five years, or for lives, a computation is to be made, of what will be at the end of forty-five years, the actual value of such part of the annuities as may be then outstanding, and the sum to be placed to the account of the commissioners is to be equal to one per cent. on this computed future value. By this means the immediate progress of the fund was accelerated, and future loans were put into a regular course of redemption.

This appropriation of one per cent. was to form a distinct fund; and a separate account was directed to be kept of the progress of each fund, by which it appeared, that on the first of February, 1802, the original fund had increased to 2,534,187*l.* 1*s.* 9*d.* and the new fund to 3,275,145*l.* 2*s.* 3*d.* It was now deemed expedient to unite the two funds, and to apply the whole amount indiscriminately to the reduction of the total debt. With this view, the former injudicious limitation of a fund established professedly on the principle of compound interest was done away; the usual annual grant of 200,000*l*, per annum was made a permanent charge upon the consolidated fund; and the whole amount of the sinking fund was directed to be regularly applied to the purchase or redemption of stock, "so as that the whole of the several redeemable public annuities, now charged upon the public funds of Great Britain, shall be paid off within forty five years from the respective periods of the creation of such respective charges and public annuities."

Particulars of the Sums constituting the Sinking Fund, as it stood on 1st February, 1808.

	£.	s.	d.
Original annual charge..	1,000,000	0	0
Additional issue by act of 1802..	200,000	0	0
Exchequer annuities, which expired in 1797....................	54,880	14	6
Short annuities of 1777, which expired 1787.....................	25,000	0	0
Life annuities fallen in, or unclaimed..................................	49,786	18	1
Dividend on £124,428,213 stock, at 3 per cent................	3,732,846	7	9½
Ditto......on.... 2,617,400 stock, at 4 per cent..............	104,696	0	0
Ditto......on.... 142,000 stock, at 5 per cent	7,100	0	0
One per cent. on the principal part of the capitals created since 1st February, 1793...........................	3,491,330	12	10
Appropriation for reduction of the loan of 1807..............	646,752	5	4¼
Total............................	9,312,392	18	7

Amount of the different Descriptions of Stock redeemed.

	£.
Consolidated 3 per cent annuities	54,912,000
Reduced 3 per cent. annuities.	62,611,702
Old and new South Sea annuities	6,901,000
Three per cent annuities 1751	753,000
Consolidated 4 per cent. annuities	2,617,400
Consolidated 5 per cent. annuities	142,000
Total	127,937,102

The total sum which has been paid for the amount of stock thus bought up was 79,465,877*l.* 0*s.* 10*d.*

The above statement is exclusive of the fund for the reduction of that part of the debt of Ireland which has been funded in Great Britain, by which 4,698,926*l.* 3 per cent stock had been redeemed; and likewise of the appropriation for the reduction of the Imperial debt, by which, at the above period, 829,126*l.* stock had been redeemed.

SINNET, on board a ship, a line or string made of rope yarn, consisting generally of two, six, or nine strings, which are divided into three parts, and are platted over one another, and then beaten smooth and flat with a wooden mallet. Its use is to save the ropes, or to keep them from galling.

SINUATED *leaf.* See Botany.

SINUS, denotes a cavity of certain bones, and other parts, the entrance whereof is narrow, and the bottom wider and more spacious.

Sinus, in surgery, a little cavity, or sacculus, frequently formed by a wound or ulcer, wherein pus is collected.

SIPHON, or Syphon, in hydraulics, a bended pipe, one end of which being put into a vessel of liquor, and the other hanging out of the said vessel over another, the liquor will run out from the first into the last, after the air has been sucked out of the external or lower end of the siphon, and that as long as the liquor in the upper vessel is above the upper orifice of the siphon. See Hydraulics.

SIPHONANTHUS, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Borragineæ, Jussieu. Essential character: corolla one-petalled, funnel-form, very long, inferior; berries four, one-seeded. There are two species, viz. S. indica, and S. angustifolia, natives of South America.

SIPHONIA, in botany, a genus of the Monoecia Monadelphia class and order. Essential character: calyx one-leafed; corolla none: male, anthers five, growing below the top of the column: female, style none, stigmas three, capsule tricoccous; seed one, sometimes two or three. There is but one species, viz. S. elastica, elastic gum tree.

SIPUNCULUS, in natural history, *tube-worm*, a genus of the Vermes Intestina class and order. Body round, elongated, mouth cylindrical at the end, and narrower than the body, aperture at the side. There are two species, viz. S. nudus, body covered with a close skin, and globular at the lower end, it inhabits European Seas, under stones; and is eight inches long: and S. saccatus; body covered with a loose skin, and rounded at the lower end; this is found in the American and Indian Seas, in shape it is like the former, except in being enclosed in a loose bag, and in not having the lower end globular.

SIREN, in natural history, a genus of Amphibia of the order Reptiles, or of the order Meantes an order instituted by Linnæus on account of this genus of animals alone. Generic character: body naked, with two feet, and without a tail; feet with arms and nails.

S. lacertina, or the eel-shaped siren, is most nearly allied to the lizard tribe, but differs from it in having only two feet, and those armed with claws, the body is shaped like an eel; its colour is a dark brown, speckled with white, it is often more than two feet long, and inhabits the stagnant waters of South Carolina, sometimes, however, quitting water for the land. This curious animal was discovered by the ingenious Dr. Garden, who presented several specimens of it to Linnæus, and excited the attention and curiosity of that great man, on this particular subject, to so high a degree that he asserted few things would more gratify him than a particular knowledge of

the nature and habits of a creature so extraordinary. The siren, if thrown with great force upon the ground, will break in several places, resembling, in this instance, a species of the anguis. See Amphibia, Plate II. fig. 3.

S. anguina, or the anguine siren, is a native of a particular lake in Carniola, from which the water regularly drains off during the summer; during which time the bottom produces corn, or pasture. In autumn the water returns with considerable rapidity, flowing principally from springs in the neighbouring mountains. In this lake this siren is found, of the length of eleven inches, and of a pale rose colour. It has both fore and hind legs. Its movements are extremely slow and weak when it is placed in a vessel, whether with or without water; but in its native situation it is far more active. It is, by some, supposed to be the larva of a lizard, and by others imagined to be a complete animal. Its habits are predatory, and it subsists on the smaller inhabitants of the water.

S. pisciformis, or the fish-formed siren, is concluded to be a native of Mexico. In its general appearance it greatly resembles the larva of the paradoxical frog; it possesses, however, gills with outward openings, and thus resembles a fish. The feet are unfurnished with the slightest degree of web. Shaw appears strongly inclined to the idea of its being the tadpole, or larva, of some large lizard.

SIREX, in natural history, *tailed-wasp*. Mouth with a thick, horny, truncate, short, denticulate mandible; four feelers, the hind ones longer and thicker upwards; antennæ filiform, of more than twenty-four equal articulations; sting exserted, serrate, stiff; abdomen sessile, terminating in a point; wings lanceolate, incumbent, the lower ones shorter. There are twenty-six species. The larvæ of this genus are six-footed, soft, and cylindrical; the head rounded; they perforate wood, and frequently eat their way into the bowels of other insects, and their larvæ living upon and consuming their vitals; the pupa folliculate; the perfect insect lives on the nectar of flowers. The largest species is S. gigas, which surpasses the hornet in size, and is principally observed in the neighbourhood of pines: it is black, with the eyes, the base, and lower half of the abdomen, bright orange yellow. The larva inhabits decayed pines and firs. It changes to a chrysalis in July, first enveloping itself in a slight silken web, of a whitish colour: the chrysalis is of a lengthened shape, with antennæ, legs, and tube, very distinctly characterised. If the change to chrysalis takes place in summer, the fly proceeds from it in about three weeks; but if at the close of autumn, the animal continues in the chrysalis state the whole winter. The male is much smaller than the female: the eggs are deposited by the female in the decayed parts of trees. See Plate IV. Entomology, fig. 5.

SIRIUS, the *dog-star*; a very bright star of the first magnitude, in the mouth of the constellation Canis Major, or the Great Dog. This is the brightest of all the stars in our firmament, and therefore probably, says Dr. Maskelyne, the astronomer royal, the nearest to us of them all. Some, however, suppose Arcturus to be the nearest. This is one of the earliest named stars in the whole heavens. Hesiod and Homer mention only four or five constellations, or stars, and this is one of them. Sirius and Orion, the Hyades, Pleiades, and Arcturus, are almost the whole of the old poetical astronomy. The three last the Greeks formed of their own observation, as appears by the names; the two others were Egyptian. Sirius was so called from the Nile, one of the names of that river being Siris; and the Egyptians, seeing that river begin to swell at the time of a particular rising of this star, paid divine honours to the star, and called it by a name derived from that of the river, expressing the star of the Nile.

SIROCCO, a periodical wind which generally blows in Italy and Dalmatia, every year, about Easter. It blows from the south-east by south; it is attended with heat, but not rain; its ordinary period is twenty days, and it usually ceases at sun-set. When the sirocco does not blow in this manner, the summer is almost free from westerly winds, whirlwinds, and storms. This wind is prejudicial to plants, drying and burning up their buds; though it hurts not men any otherwise than by causing an extraordinary weakness and lassitude; inconveniences that are fully compensated by a plentiful fishing, and a good crop of corn on the mountains. In the summer time, when the westerly wind ceases for a day, it is a sign that the sirocco will blow the day following, which usually begins with a sort of whirlwind.

SISON, in botany, *hone-wort*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ, or Umbelli-

feræ. Essential character: involucres mostly four-leaved; fruit ovate, striated. There are seven species.

SISYMBRIUM, in botany, *water-cress*, or *water-rocket*, a genus of the Tetradynamia Siliquosa class and order. Natural order of Siliquosæ, Cruciformes, or Cruciferæ. Essential character: silique opening, with straightish valves; calyx and corolla spreading. There are fifty-three species.

SISYRINCHIUM, in botany, a genus of the Monodelphia Triandria class and order. Natural order of Ensatæ. Irides, Jussieu. Essential character: spathe two-leaved; calyx none; petals six, almost equal; style one; capsule three-celled, inferior. There are ten species.

SITE, or SCITE, denotes the situation of an house, messuage, &c. and sometimes the ground-plot, or spot of earth it stands on. In logic, situs is one of the predicaments declaring a subject to be so and so placed: and in geometry and algebra, it denotes the situation of lines, surfaces, &c.

SITTA, the *nut-hatch*, in natural history, a genus of birds of the order Picæ. Generic character: bill straight; upper mandible a little longer; nostril small, and covered with bristles; tongue short, jagged, and horny at the tip; four toes, the back one as large as the middle fore one. Latham notices seven species, and Gmelin twelve. The following is the principal: S. Europea, or the European nut-hatch. This bird weighs about an ounce. Its manners much resemble those of the wood-pecker, in whose deserted nests it often builds. When the female is in a state of incubation, if she be at all annoyed by the touch of a stick, she will utter a violent kind of serpent-like hiss. She is supplied with food, in ample abundance during her sitting, by the most active assiduity of her companion. The food of these birds consists of caterpillars, and all sorts of beetles and insects, as well as nuts, the last of which they are said to hoard; and they crack them by the stroke of their bill with extreme dexterity. They run up and down trees in restless pursuit, like the wood-pecker. They are not migratory from England, but, like many other birds, change their haunts, from the open country, as winter approaches, to reside during the cold season in gardens, orchards, and other warm inclosures. In a state of confinement they rarely perch like other birds; and almost always sleep standing on the flooring of their cage.

SIUM, in botany, *water-parsnep*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ, or Umbelliferæ. Essential character: involucre many-leaved; petals cordate; fruit sub-ovate, striated. There are nineteen species.

SIZE, is a sort of glue, used by painters, &c. The shreds and parings of leather, parchment, or vellum, being boiled in water and strained, make size. This substance is used in many trades. Mr. Boyle mentions, among other uses, that fine red stands and hanging shelves are coloured with ground vermillion tempered with size, and when dry are laid over with common varnish. There is also a size made of isinglass, in the same manner, and for the like purposes; but this size will not keep above three or four days, so that no more should be made of it at once than present occasion requires.

The manner of using size is to melt some of it over a gentle fire, and scraping as much whiting into it as may only colour it, let them be well incorporated together; after which you may whiten frames, &c. with it. After it dries, melt the size again, and put more whiting, and whiten the frames, &c. seven or eight times, letting it dry between each time: but before it is quite dry, between each washing, you must smooth and wet it over with a clean brush pencil in fair water.

SKAITE, in ichthyology, the variegated raia, with the middle of the back smooth, and one row of spines on the tail. See RAIA.

SKATING, an exercise on ice, both graceful and healthy. Although the ancients were remarkable for their dexterity in most of the athletic sports, yet skating seems to have been unknown to them. It may therefore be considered as a modern invention, and probably it derived its origin in Holland, where it was practised, not only as a graceful and elegant amusement, but as an expeditious mode of travelling when the lakes and canals were frozen up during winter. In Holland long journeys are made upon skates with ease and expedition; but in general less attention is there paid to graceful and elegant movements, than to the expedition and celerity of what is called journey skating. It is only in those countries where it is considered as an amusement, that its graceful attitudes and movements can be studied; and there is no exercise whatever better calculated to set off the human figure to advantage. The acquirement of most exercises may be at-

tained to an advanced period of life, but to become an expert skater, it is necessary to begin the practice of the art at a very early age. It is difficult to reduce the art of skating to a system. It is principally by the imitation of a good skater that a young practitioner can form his own practice. Those who wish to be proficients, should begin at an early period of life, and should first endeavour to throw off the fear which always attends the commencement of an apparently hazardous amusement. They will soon acquire a facility of moving on the inside; when they have done this, they must endeavour to acquire the movement on the outside of the skates, which is nothing more than throwing themselves upon the outer edge of the skate, and making the balance of their body tend towards that side, which will necessarily enable them to form a semicircle. In this much assistance may be derived from placing a bag of lead shot in the pocket next to the foot employed in making the outside stroke, which will produce an artificial poise of the body, which afterwards will become natural by practice. At the commencement of the outside stroke, the knee of the employed limb should be a little bended, and gradually brought to a rectilinear position when the stroke is completed. When the practitioner becomes expert in forming the semicircle with both feet, he is then to join them together, and proceed progressively and alternately with both feet, which will carry him forward with a graceful movement. Care should be taken to use very little muscular exertion, for the impelling motion should proceed from the mechanical impulse of the body thrown into such a position as to regulate the stroke. At taking the outside stroke, the body ought to be thrown forward easily, the unemployed limb kept in a direct line with the body, and the face and eyes directly looking forward: the unemployed foot ought to be stretched towards the ice, with the toes in a direct line with the leg. In the time of making the curve, the body must be gradually, and almost imperceptibly raised, and the unemployed limb brought in the same manner forward, so that, at finishing the curve, the body will bend a small degree backward, and the unemployed foot will be about two inches before the other, ready to embrace the ice, and form a correspondent curve. The muscular movement of the whole body must correspond with the movement of the skate, and should be regulated so as to be almost imperceptible to the spectators. Particular attention should be paid in carrying round the head and eyes with a regular and imperceptible motion, for nothing so much diminishes the grace and elegance of skating as sudden jerks and exertions, which are too frequently used by the generality of skaters. The management of the arms likewise deserves attention. There is no mode of disposing of them more gracefully in skating outside, than folding the hands into each other, or using a muff.

SKELETON, in anatomy, an assemblage or arrangement of all the bones of a dead animal, dried, cleansed, and disposed in their natural situation, and kept in that order by means of wires, &c.

Skeleton, *natural*. This is so termed in opposition to an artificial skeleton, when the bones are retained in their proper places by their natural ligaments, which are dried upon the articulations. Natural skeletons of frogs, mice, birds, and other small animals, are easily made by putting them into a box, perforated with holes, and burying them in or near a large ant hill. The larger the species of ant, the more quickly will the work be performed. These animals will completely remove the muscular parts, and leave the skeleton in the posture in which it was originally placed.

SKIFF, or Squiff, the least of two ship-boats, serving chiefly to go ashore in, when the ship is in harbour.

SKIMMIA, in botany, a genus of the Tetrandria Monogynia class and order. Essential character: calyx four-parted; petals four, concave; berry four-seeded. There is but one species, viz. S. japonica, a native of Japan, near Nagasaki.

SKIN. See Cutis.

SKINNER, one who works in skins.

SKIRMISH, in war, a disorderly kind of combat or encounter, in presence of two armies, between small parties or persons, who advance from the body for that purpose, and introduce to a general and regular fight. See Tactics.

SKULL, in anatomy, that part of the head which forms its great bony cavity; and in a living subject contains the brain. See Anatomy.

SKY, the blue expanse of air and atmosphere. The azure colour of the sky Sir Isaac Newton attributes to vapours beginning to condense there, and which have got consistence enough to reflect the most reflexible rays.

SLAG, is a term used by the persons employed in working minerals, to express any hard vitrescent generally coloured opaque mass, produced by the fusion of any stony or metallic mixture. It generally consists of the matrix of the ore, and any saline or earthy flux that may have been used. The slag of iron founderies is for the most part composed of the earthy part of the ore, of the lime used as a flux, and the whole coloured with a part of the oxide of iron. Slag differs from scoria, in being more dense, and more completely vitrified, whereas the scoria, or dross is lighter and porous. When the slag is very opaque and heavy, it contains a considerable quantity of metal, and in that case it may be worth while to work it over again. Slag in many parts of the country is used for mending roads, for which it makes a capital material when a little worn down, being hard, and almost impenetrable by water.

SLATE, a well known neat, convenient, and durable material, for the covering of the roofs of buildings. There are great varieties of this substance, and it likewise differs very greatly in its qualities and colours. In some places it is found in thick lamina or flakes, while in others it is thin and light. The colours are white, brown, and blue. It is so durable in some cases, as to have been known to continue sound and good for centuries. However, unless it should be brought from a quarry of well reputed goodness, it is necessary to try its properties, which may be done by striking the slate sharply against a large stone, and if it produce a complete sound, it is a mark of goodness, but if in hewing, it does not shatter before the edge of the sect, or instrument commonly used for that purpose, the criterion is decisive. The goodness of the slate may be further estimated by its colour. the deep black blue is apt to imbibe moisture, but the lighter blue is always the least penetrable: the touch also may be in some degree a guide, for a good firm stone feels somewhat hard and rough, whereas an open slate feels very smooth, and as it were greasy. And another method of trying the goodness of slate, is to place the slate stone lengthwise, and perpendicular in a tub of water, about half a foot deep, care being taken that the upper or unimmersed part of the slate be not accidentally wetted by the hand, or otherwise: let it remain in this state twenty-four hours; if good and firm stone, it will not draw water more than half an inch above the surface of the water, and that perhaps at the edges only, those parts having been a little loosened in the hewing, but a spongy defective stone will draw water to the very top. There is still another mode, held to be infallible. First weigh two or three of the most suspected slates, noting the weight; then immerge them in a vessel of water twelve hours, take them out, and wipe them as clean as possible with a linen cloth, and if they weigh more than at first, it denotes that quality of slate which imbibes water, a drachm is allowable in a dozen pounds, and no more. In the laying of this material, a bushel and a half of lime, and three bushels of fresh water sand, will be sufficient for a square of work, but if it be pin plastered, it will take above as much more: but good slate well laid and plastered to the pin will lie an hundred years, and on good timber a much longer time. It has been common to lay the slates dry, or on moss only. When they are to be plastered to the pin, then about the first quantity of lime and sand will be sufficient for the purpose. See THONSCHIEFER.

SLAVES and SLAVERY. Pure and proper slaves do not, nay cannot, subsist in England; such, that is, whereby an absolute and unlimited power is given to the master, over the life and fortune of the slave. And indeed, it is repugnant to reason, that such a state should subsist any where; and the law of England abhors, and will not endure, the existence of slavery within this nation, so that when an attempt was made to introduce it, by statute 1 Edward VI. cap. 3, which ordained, that all idle vagabonds should be made slaves, and fed upon bread and water, on small drink, and refuse meat, should wear a ring of iron round their necks, arms, or legs; and should be compelled by beating, chaining, or otherwise, to perform the work assigned them, were it never so vile; the spirit of the nation could not brook this condition, even in the most abandoned rogues; and therefore this statute was repealed in two years afterwards, by statute 3 and 4 Edward VI. cap. 16. And now it is laid down, that a slave, or negro, the instant he lands in England, becomes a free man, that is, the law will protect him in the enjoyment of his person and his property. Yet, with regard to any right which the master may have lawfully acquired to the perpetual service of John, or Thomas, this, says Blackstone, will remain exactly in the

same state as before: [what that right is not, we shall presently see]: hence too it follows, that the infamous and unchristian practice of withholding baptism from negro servants, lest they should thereby gain their liberty, is totally without foundation, as well as without excuse. The law of England acts upon general and extensive principles: it gives liberty, rightly understood, that is, protection, to a Jew, a Turk, or a Heathen, as well as to those who profess the true religion of Christ; and it will not dissolve a civil obligation between master and servant, on account of the alteration of faith in either of the parties; but the slave is entitled to the same protection in England before, as after baptism; and, whatever, service the Heathen negro owed of right to his American master, by general not by local law, the same (whatever it be) is he bound to render when brought to England and made a Christian.

In the celebrated case of James Somersett, it was decided, that a Heathen negro, when brought to England, owes no service to an American, or any other master. James Somersett had been made a slave in Africa, and was sold there: from thence he was carried to Virginia, where he was bought, and brought by his master to England.

Here he ran away from his master, who seized him and carried him on board a ship, where he was confined, in order to be sent to Jamaica to be sold as a slave. Whilst he was thus confined, a habeas corpus was granted, ordering the captain of the ship "to bring up the body of James Somersett, with the cause of his detainer:" the above mentioned circumstances being stated on the return to the writ, after much discussion in the Court of King's Bench, the court were unanimously of opinion, that the return was insufficient, and that Somersett ought to be discharged.

In consequence of this decision, if a ship laden with slaves was obliged to put into an English harbour, all the slaves on board might (and Mr. Christian says ought to) be set at liberty. Though there are acts of parliament which recognise and regulate the slavery of negroes, yet it exists not in the contemplation of the common law: and the reason they are not declared free before they reach an English harbour, is only because their complaints cannot sooner be heard and redressed by the process of an English court of justice.

Liberty, by the English law, depends not on the complexion; and what was said even in the time of Queen Elizabeth is now substantially true, that the air of England is too pure for a slave to breathe in.

By statute 30 George III. c. 33, (continued and amended by statute 31 George III. c. 54, 32 George III. c. 52, and subsequent acts; and explaining and amending a former statute of 29 George III. c. 66); several humane provisions were made to restrain the cruelties practised in the African slave trade, bounties were given to the masters and surgeons of ships delivering the slaves well at their destined port, &c. This, perhaps, was a happy prelude to the abolition of that detestable commerce which has been so gloriously accomplished. See also statute 35 George III. c. 90: and the Journals of the House of Commons.

An African company was also established by statute 31 George III. c. 55, for carrying on a trade between Great Britain and the coasts and countries of Africa; and a colony was for that purpose established on the peninsula of Sierra Leone. This company was intended to supersede, in time, the necessity of the African slave trade, by raising sugars there by native Africans; it being one of the conditions of the act, that the company shall not deal in nor employ slaves. The company is to last for thirty-one years from July 1st, 1791. At length, as a last act of the administration to which Mr. Fox had belonged, the abolition of the slave trade as respects the subjects of Great Britain, and her colonies was effected by act of parliament in the year 1807. May this brilliant example of justice be followed by other nations.

SLEDGE, a kind of carriage without wheels, for the conveyance of very weighty things, as huge stones, &c.

This is also the name of a large smith's hammer, to be used with both hands. Of this there are two sorts; the upland-sledge, which is used by under-workmen, when the work is not of the larger sort; it is used with the hands before, and they seldom raise it higher than their head; but the other, which is called the about sledge, and which is used for battering or drawing out the largest work, is held by the handle with both hands, and swung round over their heads, at their arm's end, to strike as hard a blow as they can.

SLEEPERS, in a ship, timbers lying before and aft, in the bottom of the ship, as the rung-heads do: the lowermost of them

is bolted to the rung-heads, and the upper most to the futtocks and rungs.

SLING, an instrument serving for casting stones with great violence. The inhabitants of the Balearic islands were famous in antiquity, for the dexterous management of the sling; it is said they bore three kinds of slings, some longer, others shorter, which they used according as their enemies were either nearer or more remote. It is added, that the first served them for a head band, the second for a girdle, and that a third they constantly carried with them in the hand.

SLINGS *of a yard*, ropes fixed round its middle, and serving to suspend it for the greater ease of working, or for security in an engagement; in the latter case they usually add iron chains to the slings of the lower yards. Boat-slings, are strong ropes furnished with hooks and iron thimbles, by which to hook the tackle, in order to hoist the boats in or out of the ship; the hooks of the slings are applied to ring bolts fixed in the keel, and extremities of the boat.

SLINGING is used variously at sea, but chiefly for the hoisting up casks, or other heavy things, with slings, *i. e.* contrivances of ropes spliced into themselves, at either end, with one eye big enough to receive the cask, or other thing, to be slung.

SLOANEA, in botany, so named in memory of Sir Hans Sloane, Bart., a genus of the Polyandria Monogynia class and order. Natural order of Amentaceæ. Tiliaceæ, Jussieu. Essential character: calyx, one-leafed, from five to nine-cleft; corolla none; anthers growing to the filaments, below the top; capsule echinate, from three to six celled, from three to six valved; seeds two in a berried aril. There are three species.

SLOATH or SLOTH. See BRADYPUS.

SLOOP, in naval affairs, a small vessel, furnished with one mast, the main sail of which is attached to a gaff above, to the mast on its foremost edge, and to a boom below, it differs from a cutter by having a fixed steering bow-sprit, and a jib-stay: the sails also are less in proportion to the size of the vessel. Sloops of war are vessels commanded by officers in a middle rank between a lieutenant and a post captain: these are styled masters and commanders. They carry from ten to eighteen guns, and are variously rigged as ships, brigs, schooners, and sometimes cutters.

SLUICE, in hydraulics, a frame of timber, stone, earth, &c. serving to retain and raise the water of the sea, a river, &c. and on occasion to let it pass: such is the sluice of a mill, which stops and collects the water of a rivulet, &c. in order to discharge it at length, in greater plenty, upon the mill-wheel: such also are those used in drains, to discharge water off lands; and such are the sluices of Flanders, &c. which serve to prevent the waters of the sea overflowing the lower lands, except when there is occasion to drown them. Sometimes there is a canal between two gates or sluices, in artificial navigation, to save the water, and render the passage of boats equally easy and safe, upwards and downwards; as in the sluices of Briare, in France, which are a kind of massive walls, built parallel to each other at the distance of twenty or twenty-four feet, closed with strong gates at each end, between which is a kind of canal or chamber, considerably longer than broad, wherein a vessel being inclosed, the water is let out at the first gate, by which the vessel is raised fifteen or sixteen feet, and passed out of this canal into another much higher. By such means a boat is conveyed out of the Loire into the Seine, though the ground between them rise above one hundred and fifty feet higher than either of those rivers.

The construction of sluices ought to be conducted by an able engineer, who is well acquainted with the action of fluids in general; and particularly with the situation of the place, the nature of the soil, &c. where the sluice is to be erected; if on the sea-shore, he ought to be perfectly well acquainted with the effects of the sea on that coast, and the seasons when it is calm or stormy, that he may be able to prevent the fatal accidents thence arising: and, if in a river, it is necessary to know whether it usually overflows its banks, and at what seasons of the year its waters are highest and lowest. The machines for driving the piles should be placed about forty yards from the side of the sluice, above and below it. As to the depth of sluices, it must be regulated by the uses for which they are designed; thus if a sluice is to be erected at the entrance of a bason for shipping, its depth must correspond with the draught of water of the largest ship that may, at any time, have occasion to enter thereby. The rule usually observed, is to make the surface of the bottom of the canal on a level with the low-water-mark: but if the bottom of the harbour and canal be such, as to be capable of becoming deeper by the action of the water, Belidor very justly ob-

serves, that the bottom of the sluice-work should be made deeper than either.

When a sluice is to be placed at the bottom of an harbour, in order to wash away the filth that may gather in it, by means of the waters of a river or canal, in this case the bottom of the sluice-work should be two feet or eighteen inches higher than the bottom of the harbour, that the water may run with the greater violence.

An engineer ought always to have in his view, that the faults committed in the construction of sluices are almost always irreparable. We shall therefore lay down some rules, from Belidor, for avoiding any oversight of this kind: 1. In order to adjust the level of the sluice-work with the utmost exactness, the engineer ought to determine how much deeper it must be than a fixed point: and this he should mark down in his draught, in the most precise terms possible. 2. When the proper depth is settled, the foundation is next to be examined; and here the engineer cannot be too cautious, lest the apparent goodness of the soil deceive him: if the foundation is judged bad, or insufficient to bear the superstructure, it must be secured by driving piles, or a grate work of carpentry. 3. There should be engines enough provided for draining the water, and these should be entirely under the direction of the engineer, who is to take care that they be so placed as not to be an obstacle to the work; and also cause proper trenches to be cut, to convey the water clear off from the foundation. 4. When the sluice is to be built in a place where the workmen will be unavoidably incommoded by the waters of the sea, &c. all the stones for the mason work, as well as the timbers for that of carpentry, should be prepared before-hand, so that when a proper season offers for beginning the work, there remains nothing to be done, but to fix every thing in its place. 5. In order to show the state of the work, an exact journal should be kept of the materials employed, to be signed every week by the chief engineer and undertaker; observing to distinguish the different pieces of materials, and the places where they were employed. 6. When an undertaker is found, who is not only able to be at the expense of providing all the materials, but likewise vigilant and active to execute whatever is judged necessary for the perfection of the work, it would be the worst of policy to give the preference to others, who, through ignorance, or dishonesty, bring in estimates lower than it is possible to execute the work as it ought. However, that the conditions of the contract may be properly executed, the chief engineer, or other persons of unquestionable understanding and honesty, commissioned for that purpose, should take care that able workmen be employed, and that they execute their several parts in a proper manner.

Sluices are made different ways, according to the uses they are intended for: when they serve for navigation, they are shut with two gates, presenting an angle towards the stream; but when made near the sea, there are two pair of gates, one to keep the water out, and the other to keep it in, as occasion requires: the pair of gates next the sea present an angle that way, and the other pair the contrary way; the space inclosed by these gates is called a chamber. When sluices are designed to detain the water in some parts of the ditch of a fortress, they are made with shutters to slide up and down in grooves, and when they are made to raise an inundation, they are then shut by means of square timbers let down into cullises, so as to lie close and firm. Particular care must be taken, in the building of a sluice, to lay the foundation in the securest manner possible; to lay the timber-grates and floors in such a manner, that the water cannot penetrate through any part, otherwise it will undermine the work; and, lastly, to make the grates of a proper strength, in order to support the pressure of the water, and yet to use no more timber than is necessary.

SMACK, a small vessel with but one mast. Sometimes they are employed as tenders on a man of war, and are used for fishing upon the coast, &c.

SMALT, a kind of glass of a dark-blue colour, which, when levigated, appears of a most beautiful colour; and if it could be made sufficiently fine, would be an excellent succedaneum for ultramarine, as not only resisting all kinds of weather, but even the most violent fires. It is prepared by melting one part of oxide of cobalt with two of flint powder, and one of potass. At the bottoms of the crucibles in which the smalt is manufactured, we generally find a regulus of a whitish colour inclining to red, and extremely brittle. This is melted afresh, and, when cold, separates into two parts; that at the bottom is the cobaltic regulus, which is employed to make more of the smalt; the other is bismuth.

SMARAGDITE, in mineralogy. This

stone was called smaragdite, by M. Saussure, from some resemblance which it has to the emerald. Never crystallized. Its texture is foliated. Easily divided into plates. The laminæ are inflexible. Fracture even. Specific gravity 3. Colour, in some cases, fine green; in others it has the grey colour and metallic lustre of mica: it assumes all the shades of colour between these two extremes.

SMEATON (JOHN), in biography, an eminent civil engineer, was born the 28th of May, 1724, O.S. at Austhorpe, near Leeds, in a house built by his grandfather, and where his family have resided ever since. The strength of his understanding and the originality of his genius appeared at an early age; his playthings were not the playthings of children, but the tools which men employ, and he appeared to have greater entertainment in seeing the men in the neighbourhood work, and asking them questions, than in any thing else. One day he was seen, to the distress of his family, on the top of his father's barn, fixing up something like a windmill. Another time he attended some men fixing a pump at a neighbouring village, and observing them cut off a piece of bored pipe, he was so lucky as to procure it, and he actually made with it a working pump that raised water. These anecdotes refer to circumstances that are said to have happened while he was in petticoats, and most likely before he attained his sixth year.

About his fourteenth and fifteenth year he had made for himself an engine for turning, and wrought several presents to his friends of boxes in ivory or wood, very neatly turned. He forged his iron and steel, and melted his metal, he had tools of every sort for working in wood, ivory, and metals. He had made a lathe, by which he had cut a perpetual screw in brass, a thing little known at that day, which was the invention of Mr. Henry Hindley, of York, with whom Mr. Smeaton soon became acquainted, and they spent many a night at Mr. Hindley's house till day light, conversing on those subjects. Thus had Mr. Smeaton, by the strength of his genius and indefatigable industry, acquired, at the age of eighteen, an extensive set of tools, and the art of working in most of the mechanical trades, without the assistance of any master. A part of every day was generally occupied in forming some ingenious piece of mechanism.

Mr. Smeaton's father was an attorney, and desirous of bringing him up to the same profession, Mr. Smeaton therefore came up to London in 1742, and attended the courts in Westminster Hall, but finding, as his common expression was, that the law did not suit the bent of his genius, he wrote a strong memorial to his father on that subject, whose good sense from that moment left Mr. Smeaton to pursue the dictates of his genius in his own way.

In 1751, he began a course of experiments to try a machine of his invention to measure a ship's way at sea, and also made two voyages in company with Dr. Knight, to try it, and a compass of his own invention and making, which was made magnetical by Dr. Knight's artificial magnets. The second voyage was made in the Fortune sloop of war, commanded at that time by Captain Alexander Campbell.

In 1753, he was elected member of the Royal Society: the number of papers published in their Transactions will show the universality of his genius and knowledge.

In 1759, he was honoured by an unanimous vote with their gold medal, for his paper intitled "An experimental Inquiry concerning the natural Powers of Water and Wind to turn Mills, and other Machines, depending on a circular Motion." This paper, he says, was the result of experiments made on working models in the year 1752 and 1753, but not communicated to the Society till 1759, before which time he had an opportunity of putting the effect of these experiments into real practice, in a variety of cases, and for various purposes, so as to assure the Society he had found them to answer.

In December, 1755, the Eddystone light-house was burnt down. Mr. Weston, the chief proprietor, and the others, being desirous of rebuilding it in the most substantial manner, inquired of the Earl of Macclesfield, then President of the Royal Society, whom he thought the most proper to rebuild it, his Lordship recommended Mr. Smeaton. Mr. Smeaton undertook the work, and completed it in the summer of 1759. Of this Mr. Smeaton gives an ample description in the volume he published in 1791.

Though Mr. Smeaton completed the building of the Eddystone light-house in 1759, a work that does him so much credit, yet it appears he did not soon get into full business as a civil engineer, for in 1764, while in Yorkshire, he offered himself a candidate for one of the receivers of the Derwentwater estate; and on the thirty-

first of December, in that year, he was appointed, at a full board of Greenwich Hospital, in a manner highly flattering to himself, when two other persons strongly recommended, and powerfully supported, were candidates for the employment. In this appointment he was very happy, by the assistance and abilities of his partner, Mr. Walton, one of the receivers, who taking upon himself the management and accounts, left Mr. Smeaton leisure and opportunity to exert his abilities on public works, as well as to make any improvements in the mills, and in the estates, of Greenwich Hospital. By the year 1775, he had so much business as a civil engineer, that he wished to resign this appointment; and would have done it then, had not his friends, the late Mr. Stuart, the hospital surveyor, and Mr. Ibbetson, their secretary, prevailed upon him to continue in the office about two years longer.

Mr. Smeaton having now got into full business as a civil engineer, performed many works of general utility. He made the river Calder navigable, a work that required great skill and judgment, owing to the very impetuous floods in that river. He planned and attended the execution of the great canal in Scotland, for conveying the trade of the country either to the Atlantic or German Ocean; and having brought it to the place originally intended, he declined a handsome yearly salary, in order that he might attend to the multiplicity of his other business.

On the opening of the great arch at London bridge, the excavation around and under the starlings was so considerable, that the bridge was thought to be in great danger of falling. He was then in Yorkshire, and was sent for by express, and arrived with the utmost dispatch. "I think" says Mr. Holmes, the author of his Life, "it was on a Saturday morning, when the apprehension of the bridge was so general that few would pass over or under it. He applied himself immediately to examine it, and to sound about the starlings as minutely as he could; and the committee being called together, adopted his advice, which was to repurchase the stones that had been taken from the middle pier, then lying in Moorfields, and to throw them into the river to guard the starlings." Nothing shows the apprehensions concerning the falling of the bridge more than the alacrity with which this advice was pursued; the stones were repurchased that day, horses, carts, and barges were got ready, and they began the work on Sunday morning. Thus, Mr. Smeaton, in all human probability, saved London bridge from falling, and secured it till more effectual methods could be taken.

The vast variety of mills which Mr. Smeaton constructed, so greatly to the satisfaction and advantage of the owners, will show the great use which he made of his experiments in 1752 and 1753; for he never trusted to theory in any case where he could have an opportunity to investigate it by experiment. He built a steam engine at Austhorpe, and made experiments thereon, purposely to ascertain the power of Newcomen's steam engine, which he improved and brought to a far greater degree of perfection, both in its construction and powers, than it was before.

Mr. Smeaton, during many years of his life, was a frequent attendant on parliament, his opinion being continually called for. And here his strength of judgment and perspicuity of expression had its full display. It was his constant custom, when applied to plan or support any measure, to make himself fully acquainted with it, to see its merits, before he would engage in it. By this caution, added to the clearness of his description and the integrity of his heart, he seldom failed to obtain for the bill which he supported an act of parliament. No one was heard with more attention, nor had any one ever more confidence placed in his testimony. In the courts of law he had several compliments paid him from the bench by Lord Mansfield and others, for the new light which he threw on difficult subjects.

About the year 1785, Mr. Smeaton's health began to decline; and he then took the resolution to endeavour to avoid all the business he could, so that he might have leisure to publish an account of his inventions and works, which was certainly the first wish of his heart; for he has often been heard to say, that "he thought he could not render so much service to his country as by doing that." He got only his account of the Eddystone light-house completed, and some preparations to his intended Treatise on Mills; for he could not resist the solicitations of his friends in various works: and Mr. Aubert, whom he greatly loved and respected, being chosen chairman of Ramsgate harbour, prevailed upon him to accept the place of engineer to that harbour; and to their joint efforts the

public is chiefly indebted for the improvements that have been made there within these few years, which fully appears in a report that Mr. Smeaton gave in to the board of trustees in 1791, which they immediately published.

Mr. Smeaton being at Austhorpe, walking in his garden, on the 16th of September, 1792, was struck with the palsy, and died the 28th of October. "In his illness," says Mr. Holmes, "I had several letters from him, signed with his name, but written and signed by another's pen; the diction of them showed that the strength of his mind had not left him. In one written the 26th of September, after minutely describing his health and feelings, he says, 'In consequence of the foregoing, I conclude myself nine-tenths dead; and the greatest favour the Almighty can do me, as I think, will be to complete the other part; but as it is likely to be a lingering illness, it is only in his power to say when that is likely to happen'."

Mr. Smeaton had a warmth of expression that might appear to those who did not know him well to border on harshness; but those more intimately acquainted with him knew that it arose from the intense application of his mind, which was always in the pursuit of truth, or engaged in investigating difficult subjects. He would sometimes break out hastily, when any thing was said that did not tally with his ideas; and he would not give up any thing he argued for, till his mind was convinced by sound reasoning. In all the social duties of life he was exemplary; he was a most affectionate husband, a good father, a warm, zealous, and sincere friend, always ready to assist those he respected, and often before it was pointed out to him in what way he could serve them. He was a lover and encourager of merit wherever he found it; and many men are in a great measure indebted to his assistance and advice for their present situation. As a companion, he was always entertaining and instructive; and none could spend any time in his presence without improvement.

As a civil engineer, he was perhaps unrivalled, certainly not excelled by any one, either of the present or former times. His building the Eddystone light-house, were there no other monument of his fame, would establish his character. The Eddystone rocks have obtained their name from the great variety of contrary sets of the tide or current in their vicinity. They are situated nearly S. S. W. from the middle of Plymouth Sound. Their distance from the port of Plymouth is about 14 miles. They are almost in the line which joins the Start and the Lizard Points; and as they lie nearly in the direction of vessels coasting up and down the channel, they were unavoidably, before the establishment of a light-house there, very dangerous, and often fatal to ships. Their situation with regard to the Bay of Biscay and the Atlantic is such, that they lie open to the swells of the bay and ocean, from all the south-western points of the compass; so that all the heavy seas from the south-west quarter come uncontrolled upon the Eddystone rocks, and break upon them with the utmost fury. Sometimes, when the sea is to all appearance smooth and even, and its surface unruffled by the slightest breeze, the ground swell meeting the slope of the rocks, the sea beats upon them in a frightful manner, so as not only to obstruct any work being done on the rock, or even landing upon it, when, figuratively speaking, you might go to sea in a walnut-shell. That circumstances fraught with danger surrounding it should excite mariners to wish for a light-house, is not wonderful; but the danger attending the erection leads us to wonder that any one could be found hardy enough to undertake it. Such a man was first found in the person of Mr. H. Winstanley, who, in the year 1696, was furnished by the Trinity House with the necessary powers. In 1700 it was finished; but in the great storm of November, 1703, it was destroyed, and the projector perished in the ruins. In 1709 another, upon a different construction, was erected by a Mr. Rudyerd, which, in 1755, was unfortunately consumed by fire. The next building was, as we have seen, under the direction of Mr. Smeaton, who, having considered the errors of the former constructions, has judiciously guarded against them, and erected a building, the demolition of which seems little to be dreaded, unless the rock on which it is erected should perish with it. Of his works, in constructing bridges, harbours, mills, engines, &c. &c. it were endless to speak. Of his inventions and improvements of philosophical instruments, as of the air pump, the pyrometer, hygrometer, &c. &c. some idea may be formed from the list of his writings. See Hutton's Dict.

SMELL, *sense of*. The sense of smell is very nearly allied to that of taste, and indeed many of those pleasurable sensations

which are usually referred to the taste, as being received during the act of eating and swallowing, really belong to the smell. The organ of smell is a membrane or skin, overspread with nerves, which line the internal cavity of the nostrils, and the surface and cavities of the bones which join the nostrils. This is affected both by the odorous particles which proceed from external substances through the nose, and by those which come from the substances which are eaten; for there is a communication between the nose and the back part of the mouth. The pains of smell are obviously designed to assist us in the proper choice of food, and prompt us to avoid such noxious vapours, as may render the air injurious to health or life. It appears also, that offensive odours, in various circumstances, contribute to generate the sense of shame, decency, &c. The pleasures of smell have a direct connection with those of taste. It is only necessary, therefore, to add to what has been said respecting the latter, that the pleasures of smell which arise from the various productions of nature, have a great share in the formation and vividness of some of our mental pleasures; particularly those which arise from the view of rural objects and scenes, and from the representations of them by poetry and painting.

SMELTING, in metallurgy, the fusion or melting of the ores of metals, in order to separate the metalline part from the earthy, stony, and other parts. The art of fusing the ores after roasting, is the principal and most important of metallurgic operations, all the other being preliminary or preparative to this. The whole attention of the miner is directed towards this process; to this all his efforts are applied, because it affords the truly useful product to which his hopes are directed. Though it consists, in general, in fusing the roasted ore to extract the metal, and in this point of view it seems to present a simple and uniform operation, there is, nevertheless, no operation which differs so much in its circumstances, according to the nature of the metal, and the ore, required to be treated, and according to the furnaces made use of, the nature and quantity of the combustible employed, the energy, duration, and administration of the fire, the addition of an appropriate flux, the heat being applied in the midst of the coal, or in crucibles, the period, the length of time, and the mode of casting the fused metal; every thing, even the form of the metal which flows out, varies, and presents to the observer very remarkable differences.

SMILAX, in botany, a genus of the Dioecia Hexandria class and order. Natural order of Sarmentaceæ. Asparagi, Jussieu. Essential character: calyx six-leaved; corolla none: female, styles three; berry three-celled; seeds two. There are twenty-three species; of these, the S. sarsaparilla, which affords the sarsaparilla root, is the most valuable. This species has stems of the thickness of a man's finger; they are jointed, triangular, and beset with crooked spines; the leaves are alternate, smooth, and shining on the upper side; on the other side are three nerves or costæ, with sundry small crooked spines; the flower is yellow, mixed with red; the fruit is a black berry, containing several brown seeds. Sarsaparilla delights in low moist grounds, and near the banks of rivers. The roots run superficially under the surface of the ground. The gatherers have only to loosen the soil a little, and to draw out the long fibres with a wooden hook. In this manner they proceed till the whole root is got out: it is then cleared of the mud, dried, and made into bundles. The sensible qualities of sarsaparilla are mucilaginous and farinaceous, with a slight degree of acrimony; the latter, however, is so slight, as not to be perceived by many; and it is thought that its medicinal powers may fairly be ascribed to its demulcent and farinaceous qualities. The China, or oriental species of China root, has roundish, prickly stalks, and red berries, and is a native of China and Japan. The pseudo-China, or occidental species, has rounder, smooth stalks, and black berries, grows wild in Jamaica and Virginia, and bears the colds of our own climate. At present the China root is very rarely made use of, having, for some time, given place to sarsaparilla, which is supposed to be more effectual. Prosper Alpinus informs us, that this root is in great esteem among the Egyptian women for procuring fatness and plumpness.

SMITHIA, in botany, so named in honour of James Edward Smith, M. D. P. L. S. a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: legume with distinct, one-seeded joints, connected by the style; stamina divided into two equal bodies. There is only one species, viz. S. sensitiva, annual smithia, a native of the East Indies.

SMOKE *jack*, is a very simple and com-

ambitious machine in a kitchen; so called from its being moved by means of the smoke, or rarefied air, moving up the chimney, and striking against the tail of the horizontal wheel, which, being inclined to the horizon, is thereby moved about the axis of the wheel, together with the pinion which carries the wheel, and this carries the chain which turns the spit. The wheel should be placed in the narrow part of the chimney, where the motion of the smoke is swiftest, and the greatest part of it must be made strike upon the sails.

The manner of operation of this useful machine is easily understood. The air which contributes to the burning of the fuel, and passes through the midst of it, is greatly heated, and expanding prodigiously in bulk, becomes lighter than the neighbouring air, and is therefore pushed by it up the chimney. In like manner, all the air which comes near the fire is heated, expanded, becomes lighter, and is driven up the chimney. This is called the draught or suction; but would, with greater propriety, be termed the drift of the chimney. As the chimney gradually contracts in its dimensions, and as the same quantity of heated air passes through every section of it, it is plain that the rapidity of its ascent must be greatest in the narrowest place. There the fly should be placed, because it will there be exposed to the strongest current. This air, striking the fly vanes obliquely, pushes them aside, and thus turns them round with a considerable force. If the joint of meat is exactly balanced on the spit, it is plain, that the only resistance to the motion of the fly is what arises from the friction of the pivots of the upright spindle, the friction of the pinion and wheel, the friction of the pivots of the horizontal axis, the friction of the small end of the spit, and the friction of the chain in the two pulleys. The whole of this is but a mere trifle. But there is frequently a considerable inequality in the weight of the meat on different sides of the spit: there must therefore be a sufficient overplus of force in the impulse of the ascending air on the vanes of the fly, to overcome this want of equilibrium occasioned by the unskilfulness or negligence of the cook.

SMUT, a disease in corn, which destroys entirely the germ and substance of the grain.

SMYRNIUM, in botany, *Alexanders*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ, or Umbelliferæ. Essential character: petals acuminate, keeled; fruit oblong, striated. There are seven species.

SNAFFLE, in the manege, is a very slender bit-mouth, without any branches, much used in England, the true bridles being reserved for the service of war.

SNAIL. See LIMAX.

SNAKE. See ANGUIS. The common snake is a harmless and inoffensive animal, and might even be kept tame in houses to destroy vermin.

SNAKING, in naval affairs, is the winding small ropes spirally round a large one, the former lying in the intervals between the strands of the latter, and is frequently termed worming.

SNOW, a well-known substance, formed by the freezing of the vapours in the atmosphere. It differs from hail and hoar frost, in being as it were crystallized, which they are not. This appears on examining a flake of snow by a magnifying glass; when the whole of it will appear to be composed of fine shining spicula, diverging like rays from a centre. As the flakes fall down through the atmosphere, they are continually joined by more of these radiated spicula, and thus increase in bulk like the drops of rain or hail-stones. Dr. Grew, in a discourse of the nature of snow, observes, that many parts thereof are of a regular figure, for the most part stars of six points, and are as perfect and transparent ice as any we see on a pond, &c. Upon each of these points are other collateral points, set at the same angles as the main points themselves: among which there are divers other irregular, which are chiefly broken points, and fragments of the regular ones. Others also, by various winds, seemed to have been thawed, and frozen again into irregular clusters, so that it seems as if the whole body of snow were an infinite mass of icicles irregularly figured: that is, a cloud of vapours being gathered into drops, the said drops forthwith descend; upon which descent, meeting with a freezing air as they pass through a colder region, each drop is immediately frozen into an icicle, shooting itself forth into several points, but these still continuing their descent, and meeting with some intermitting gales of warmer air, or in their continual waftage to and fro touching upon each other, some of them are a little thawed, blunted, and again frozen into clusters, or entangled so as to fall down in what we call flakes. The lightness of snow, although it is firm ice,

is owing to the excess of its surface in comparison to the matter contained under it; as gold itself may be extended in surface till it will ride upon the least breath of air. The whiteness of snow is owing to the small particles into which it is divided; for ice, when pounded, will become equally white. According to Beccaria, clouds of snow differ in nothing from clouds of rain, but in the circumstance of cold that freezes them. Both the regular diffusion of the snow, and the regularity of the structure of its parts, (particularly some figures of snow or hail which fall about Turin, and which he calls rosette), show that clouds of snow are acted upon by some uniform cause like electricity; and he endeavours to show how electricity is capable of forming these figures. He was confirmed in his conjectures by observing, that his apparatus for observing the electricity of the atmosphere never failed to be electrified by snow as well as rain. Professor Winthrop sometimes found his apparatus electrified by snow when driven about by the wind, though it had not been affected by it when the snow itself was falling. A more intense electricity, according to Beccaria, unites the particles of hail more closely than the more moderate electricity does those of snow, in the same manner as we see, that the drops of rain which fall from thunder-clouds are larger than those which fall from others, though the former descend through a less space.

Were we to judge from appearances only, we might imagine, that so far from being useful to the earth, the cold humidity of snow would be detrimental to vegetation. But the experience of all ages asserts the contrary. Snow, particularly in those northern regions where the ground is covered with it for several months, fructifies the earth, by guarding the corn or other vegetables from the intenser cold of the air, and especially from the cold piercing winds. It has been a vulgar opinion, very generally received, that snow fertilizes the land on which it falls more than rain, in consequence of the nitrous salts, which it is supposed to acquire by freezing. But it appears from the experiments of Margraaf, in the year 1731, that the chemical difference between rain and snow water is exceedingly small; that the latter is somewhat less nitrous, and contains a somewhat less proportion of earth than the former; but neither of them contain either earth, or any kind of salt, in any quantity which can be sensibly efficacious in promoting vegetation. Allowing, therefore, that nitre is a fertilizer of land, which many are upon good grounds disposed utterly to deny, yet so very small is the quantity of it contained in snow, that it cannot be supposed to promote the vegetation of plants upon which the snow has fallen. The peculiar agency of snow, as a fertilizer in preference to rain, may admit of a very rational explanation, without recurring to nitrous salts, supposed to be contained in it. It may be ascribed to its furnishing a covering to the roots of vegetables, by which they are guarded from the influence of the atmospherical cold, and the internal heat of the earth is prevented from escaping. The internal parts of the earth is heated uniformly to the forty-eighth degree of Fahrenreit's thermometer. This degree of heat is greater than that in which the watery juices of vegetables freeze, and it is propagated from the inward parts of the earth to the surface, on which the vegetables grow. The atmosphere being variably heated by the action of the sun in different climates, and in the same climate at different seasons, communicates to the surface of the earth, and to some distance below it, the degree of heat or cold which prevails in itself. Different vegetables are able to preserve life under different degrees of cold, but all of them perish when the cold which reaches their roots is extreme. Providence has, therefore, in the coldest climates, provided a covering of snow for the roots of vegetables, by which they are protected from the influence of the atmospherical cold. The snow keeps in the internal heat of the earth, which surrounds the roots of vegetables, and defends them from the cold of the atmosphere.

Snow *grotto*, an excavation made by the waters on the side of Mount Etna, by making their way under the layers of lava, and by carrying away the bed of puzzolana below them. It occurred to the proprietor, that this place was very suitable for a magazine of snow: for in Sicily, at Naples, and particularly at Malta, they are obliged, for want of ice, to make use of snow for cooling their wine, sherbet, and other liquors, and for making sweetmeats. This grotto was hired or bought by the Knights of Malta, who having neither ice nor snow on the burning rock which they inhabit, have hired several caverns on Etna, in which people, whom they employ, collect and preserve quantities of snow, to be sent to Malta when needed. This grotto

has therefore been repaired within at the expense of that order: flights of steps are cut into it, as well as two openings from above, by which they throw in the snow, and through which the grotto is enlightened. Above the grotto they have also levelled a piece of ground of considerable extent; this they have inclosed with thick and lofty walls, so that when the winds, which at this elevation blow with great violence, carry the snow from the higher parts of the mountain, and deposit it in this enclosure, it is retained and amassed by the walls. The people then remove it into the grotto through the two openings, and it is there laid up, and preserved in such a manner as to resist the force of the summer heats; as the layers of lava with which the grotto is arched above prevent them from making any impression.

When the season for exporting the snow comes on, it is put into large bags, into which it is pressed as closely as possible; it is then carried by men out of the grotto, and laid upon mules, which convey it to the shore, where small vessels are waiting to carry it away. But before those lumps of snow are put into bags, they are wrapped in fresh leaves; so that while they are conveyed from the grotto to the shore, the leaves may prevent the rays of the sun from making any impression upon them. The Sicilians carry on a considerable trade in snow, which affords employment to some thousands of mules, horses, and men. They have magazines of it on the summits of their loftiest mountains; from which they distribute it through all their cities, towns, and houses; for every person in the island makes use of snow. They consider the practice of cooling their liquors as absolutely necessary for the preservation of health; and in a climate the heat of which is constantly relaxing the fibres, cooling liquors, by communicating a proper tone to the fibres of the stomach, must greatly strengthen them for the performance of their functions.

Snow, in naval affairs, a vessel equipped with two masts, resembling the main and fore-masts of a ship, and a third small mast just abaft the main-mast, carrying a sail nearly similar to a ship's mizen; the foot of this mast is fixed in a block of wood, upon deck, and the head is attached to the after-part of the main top. The sail is called a try-sail, and hence the mast is termed a try-sail-mast. When sloops of war are rigged as snows, they are furnished with a strong rope, called a horse, instead of the try-sail-mast, the fore part of the sail being attached by rings to it. This is generally the largest of all two masted vessels employed by Europeans, and is reckoned the most convenient for navigation. See Falconer's Marine Dictionary.

SNUFF, a powder chiefly made of tobacco, the use of which is too well known to need any description here. However, though tobacco be the basis of snuff, yet a multiplicity of other matters are often added, to give it an agreeable scent. The kinds of snuff being endless, we shall only observe, that there are three grand sorts, *viz.* that which is only granulated, and called rappee; that which is reduced to a very fine powder, and called Scotch, Spanish, &c. snuff; and the third, a coarse kind, remaining after sifting the second sort.

SOAP, a composition of caustic fixed alkaline salt and oil, or other grease. It is sometimes hard and dry, sometimes soft and liquid; much used in washing, and other purposes, as well in the arts and manufactures as in domestic purposes. The manufacture of soap in and near London first began in the year 1524: before this our countrymen imported the best soap from foreign parts, though they were supplied with an inferior sort from Bristol.

The materials used in soap-making are, oil of any kind, vegetable or animal; and fixed alkali, either soda or potash. These (that is, oil and alkali) enter into the composition of every soap, and, besides, lime is essential to give the alkali the requisite degree of causticity: common salt is also employed in most of the potash soaps.

The general process for soap-making is on the whole very simple; and consists, first, in making a caustic, or partly caustic, ley, with the alkali and lime; next, of boiling the ley with the oil till they are perfectly united into a smooth uniform soap; and lastly, of drying the soap till it is become of a proper consistence for use. But though the general process is simple, and success to a certain degree may be insured by any one who puts the proper ingredients together in the plainest manner, there are a considerable number of precautions, and many minute attentions, required to make the best and most perfect article with the greatest economy. The simplest, and on the whole the most beautiful, soap is the fine white soap prepared from olive oil and soda, extracted from the best barilla, which is manufactured very largely in the countries

where the olive grows, especially in the south of France, in some parts of Italy, and in Tripoli.

Soap is manufactured in this country principally from tallow, or any other fat; and the alkali employed is either barilla or pearl-ash, or a mixture of the two, according to the price and practice of the manufacturer. But as potash alone will not make a stiff soap, recourse is had to the action of common salt, which, when added after the potash and oil are united, produces a separation of the compound from the water incorporated with it, hardens it, and renders it equal to the soda soaps. The following is the usual method of making the common white and yellow soap used in domestic purposes. White hard soap is generally made with three separate charges of ley. The potash (supposing this to be the alkali) is previously dissolved with water in a small boiler, with a little fire, and the solution is poured over a vat, containing common wood ashes mixed with lime, which makes the first and strongest ley. As soon as this has run off, the ashes are turned, more lime is added, and water is pumped on, which forms the second, or weak ley. The large boiler is then charged with the tallow, and about two-thirds of the strong ley being added, a moderate fire is kept up to incorporate the materials, which is known by their running into a stiff glue. If this does not take place in about seven hours (with 29 *cwt.* of tallow in the boiler) more alkali must be added. The tallow is then killed, or saturated, and the fire is drawn, and the materials allowed to remain at rest for a short time. Common salt is then thrown in, and stirred up with long poles till it is thoroughly incorporated, and till the matter changes from a dark coloured glue to a thin soapy substance. A brisk fire is then made, and the materials boiled for a few minutes, when the fire is again drawn, and the materials in the boiler allowed to settle for an hour and a half, during which the spent lees sink to the bottom of the boiler, and are pumped off. The second operation begins with raising the fire, and adding to the soapy mass the weak ley, which is to be managed the same as at first, and again brings it to the state of a glue, which a very little salt will restore to the saponaceous state, and after boiling and cooling the second lees are pumped off. In the third operation, the third part of the strong ley which was reserved is added, which, as before, changes the mass to a thick glue, that must be grained with salt as before. The contents are then boiled strongly for three hours, more or less, till by taking samples occasionally with a trowel, the soap feels sufficiently hard and dry to the touch, and the ley will be seen to run quite clear from the soap on the trowel, leaving this latter in round lumps. The boil of soap is then finished, by pumping off the spent ley, and scraping off a quantity of light froth from the top of the soap, and the soap is fit for framing.

Soap is soluble in alcohol. The solution of soap is decomposed by all the acids, which curdle it, or separate the oil in the form of white lumps. An excess of acid re-dissolves the curd, and the oil is transferred to the acid; but on boiling this solution, the oil separates entirely, and rises to the surface. The solution is also curdled by lime, barytic, or strontian water, and in this case the curd consists of the oil united with the earth, and concreted by this union. All the soluble salts of these and the other earthy bases equally decompose soap water, and form a curdy precipitate, which is the reason why hard water, that always contains sulphate of lime, and often other earthy salts, immediately curdles soap, instead of forming an uniform solution. The metallic salts will produce the same effect, and a combination of the oil and metallic oxide is produced. See Aikin's Dict.

SOCAGE, a tenure of lands by or for certain inferior services of husbandry to be performed to the lord of the fee. This was a tenure of so large an extent, that all the lands in England, which were not held in knight-service, were held in socage. Since the time of Charles II. all the lands in England are reduced to socage tenures.

SOCIETIES. This word includes a vast circle of associations of men, calculated in some instances to promote the cause of science and literature, and in others intended for the benefit of the individuals and their families who compose them.

Of the former class are the Royal and Antiquarian Societies, and the more recent establishments, under the term of INSTITUTIONS.

SOCIETY, *Royal*, had its origin from the voluntary intercourse of learned men, who conceived that their pursuits might be improved and forwarded by the communication of their thoughts and observations to each other during their leisure hours. Dr. Wilkins, of Wadham College, Oxford, who entertained the resident philosophers of that

university at his lodgings weekly, to this feast of reason, deserves the honour of founding the Society, as it was there the more expanded idea of future benefit to the community was generated and matured, and which would probably have been carried into effect, had not the unhappy civil war, during the reign of Charles I. banished every laudable public intention from the minds of the learned, and converted the seat of learning into a military post.

Thus expelled from Oxford, we find that many of the members of this infant society afterwards resided in London, and still cherishing the plan, they contrived to meet at Gresham College between the years 1658 and 1663. The evident advantages likely to be derived from the labours of the philosopher, who was by this means compelled to exert his best faculties to escape free from the scrutinizing observations of his brethren in science, to whom they were submitted, soon attracted the notice of those who had sufficient influence at court to procure a charter of incorporation, from a monarch whose pursuits were widely different, and which was dated April 22, 1663. This act reflecting equal honour on the age and nation, was accompanied by a declaration from the King expressed within it, that he wished to be considered in the threefold character of founder, patron, and companion.

Thus the Society received the royal protection, and became a body politic, under the direction of a president and council, who were elected by the fellows or members; the latter also cannot obtain admission without the routine of being proposed by persons already admitted, who, by this means, become responsible for the propriety of the recommendation, and a formal ballot, which takes place after a sufficient time has elapsed, to enable the Society to judge whether the candidate has just pretensions to the honourable and learned distinction of Fellow of the Royal Society, "for promoting the knowledge of natural things and useful experiments." The liberality which almost universally distinguishes the genuine philosopher, soon furnished their apartments with valuable and interesting, natural and artificial productions, and they were sufficiently numerous at the commencement of the eighteenth century to compose a folio catalogue, for which the public are indebted to Dr. Grew; since that period the contributions have greatly multiplied, and form a most important collection. The meetings are now held weekly, for the general purposes of the Society, from the middle of November till July, on Thursday evenings, between the hours of eight and nine o'clock, when those papers are read which the secretary receives in the interval between each meeting, and exhibits such curiosities as may be sent to him for that purpose. Their own declaration, made very long since, will contribute to explain the nature of the communications to this valuable institution, which is calculated to "make faithful records of all the works of nature or art which come within their reach; so that the present, as well as after ages, may be enabled to put a mark on errors which have been strengthened by long prescription; to restore truths that have been neglected; to put those already known to more various uses, and to make the way more passable to what remains unrevealed."

SOCIETY *of Antiquarians*. Though the object of this body is of rather less importance than that of the Royal Society, yet it has obtained a celebrity little inferior, as much has been done by it towards ascertaining the changes which have taken place in the surface of the earth, exclusive of the principal purpose of the association, which is to generate a liking for the study of our national antiquities; so that, in the sequel, genuine history shall be preferred to the superficial information gleaned from monastic writers; this will be still farther explained by the preamble of the charter, which asserts that the study of antiquity, and the history of former times, has ever been esteemed highly commendable and useful, not only to improve the minds of men, but also to incite them to virtuous and noble actions, and such as may hereafter render them famous and worthy examples to late posterity.

When we recollect, that from the time of Henry VIII. learning began to be more generally diffused throughout all ranks of people, and that Leland, Stowe, Camden, Dugdale, Speed, Sir Robert Cotton, and many other eminent antiquarians, used every endeavour to rouse their countrymen into a relish for their pursuits, it may be readily supposed, that attempts were made to form a society which might more effectually promote individual views; that such attempts occurred we have sufficient evidence, but that some adverse cause existed to prevent their fruition equal proof exists, in the fact, that the society did not receive the royal

sanction till 1751, when George II. granted the infant association a charter of incorporation, dated November 2, in the above year; this instrument declared the monarch to be the founder and patron of the society, which is enabled to receive and hold in perpetuity any antiquities, books, manuscripts, &c. and lands, tenements, and hereditaments, not exceeding the yearly value of one thousand pounds, which the generosity of individuals may prompt them to bestow on the members collectively; or the society may purchase property of the same description, to the same amount, without licence of alienation in mortmain.

The government of the society consists of twenty-one persons, of whom one is constituted the president, and the first so honoured was the celebrated Martin Folkes, Esq. who held that office till the 23d of April, the day appointed for all subsequent elections, which the charter declares shall be annual. The first council under the act of incorporation contained the names of Viscount Fitzwilliam, Lord Willoughby of Parham, James West, Esq. Mr. Gale, Mr. Wray, Dr. Browne Willis, Dr. Rawlinson, and Arries and Vertue, names that reflected honour on the nation, and were well calculated to confirm the credit and stability of the society, which the King ordained should be composed of men of acknowledged abilities, judging from the following excellent criterion of their pretensions, "by how much any person shall be more excelling in the knowledge of the antiquities and history of this and other nations; by how much the more they are desirous to promote the honour, business, and emoluments of this society; and by how much the more eminent they shall be for piety, virtue, integrity, and loyalty; by so much the more fit and worthy shall such person be judged of being elected and admitted into the said society."

Their transactions, as a body, are under the control of an elective director, who superintends the progress of intended works, of which the Society have published fifteen quarto volumes under the title Archæologia, illustrated with engravings, three of Vetusta Monumenta, and a very considerable number of separate prints, and particularly of elevations of cathedrals.

The general meetings of the society are held on every Thursday evening between the months of November and July, and immediately before the sitting of the Royal Society, whose apartments are separated by an anti-room, common to both, from those belonging to the Antiquarians, in Somerset House; in the left wing of which the latter have an excellent library, open to the fellows from ten till four o'clock every day, who have the further privilege of borrowing books for any time not exceeding a month, by a written application at a general meeting, or to the secretary during the recess.

Similar to the proceedings of the Royal Society, all communications must be made to the secretary, who reads those thought to possess sufficient merit, and in the same manner exhibits fragments of antiquity and drawings, all which are heard and examined in profound silence.

SOCIETY *for the encouragement of Arts, Manufactures, and Commerce.* This institution originated from the truly patriotic views of several worthy members of the community, who were sensible that rewards from a society formed of the noble, the rich, and the learned, were better calculated to produce emulation in every department of the pursuits mentioned in the title of it, than the mere prospect of advantage to be derived from the employment of individuals. The idea seems to have met the approbation of the public, and a very short time elapsed ere sufficient sums of money were procured to set this useful and respectable body in motion: we now find them fixed in a superb mansion, part of the Adelphi Buildings, splendidly adorned with paintings presented by the late Mr. Barry, the work of his own pencil, and surrounded by numerous models of articles, which render their inventors memorable, and their patrons more honourable members of society than the most adventurous military heroes of ancient or modern times.

Subscriptions for life, and by the year, and some other resources, supply the wants of the institution, which are confined to the actual expenses of their hall, their officers, and servants, and the rewards honorary and pecuniary. In explaining their motives, they say their object is to promote the arts, manufactures, and commerce of this kingdom, by giving rewards for all such useful inventions, discoveries, or improvements, as tend to that purpose; and in pursuance of this plan, the society has already expended between forty and fifty thousand pounds, advanced by the voluntary subscription of their members, and legacies bequeathed. The manner in which

the above vast sum has been distributed is most honourably explained by the secretary and other officers at the hall, and the register, exhibited at the same time, will show the very great advantages which the public derives from the institution. The meetings of the society are held every Wednesday, at seven o'clock in the evening, from October to June, and the various committees on other evenings during the session. Each member has the privilege, on any weekly meeting, of proposing a candidate for admission, provided three members sign the written instrument prescribed for that purpose. Peers of the realm, or lords of parliament, are ballotted for immediately upon being proposed, but the names of all others must be inserted in a list which the secretary suspends in the meeting room; the person is then ballotted for, and if two thirds of the members present vote in his favour, he becomes a perpetual member on paying twenty guineas, or a subscribing member upon payment of any sum amounting to not less than two guineas per annum. Every member is admitted to participate in all the transactions of the society, and may attend and vote at the several committees; besides which, he has the privilege, at the weekly meetings, of proposing two persons as auditors of the general accounts, and, by addressing a note to the registrar, of introducing his friends to examine the numerous models, machines, and productions, in different branches of arts, manufactures, and commerce, for which rewards have been bestowed; and to inspect the magnificent series of moral and historical paintings, so happily contrived and completed by James Barry, Esq. which, with some valuable busts and statues, decorate the great room. He has also the use of a valuable library, and is entitled to the annual volume of the Society's Transactions.

Our limits will not permit us to give more than the heads of the subjects for which premiums are offered, as the ramifications of each are very numerous, in order to render the operations of the society as useful as possible. They are for planting and husbandry, containing fifty-seven classes; for discoveries and improvements in chemistry, dying, and mineralogy, in twenty eight classes; for promoting the polite arts, including one class offered by the will of John Stock, Esq. for sculpture, twenty-two classes; for encouraging and improving manufactures, six classes; for inventions in mechanics, twelve classes; and to these are added premiums for the advantage of the British colonies, and the British settlements in the East Indies, in thirty-four classes. The premiums alluded to are medals of gold and silver, gold and silver pallets, and purses of ten, twenty, or thirty, &c. guineas.

As the primary object of the society, in offering these rewards, is to rouse the energy of individuals, and to give currency to their inventions and improvements which appear to promise general benefit; the society is careful to acquaint the candidates for them, "that if the means by which the respective objects are effected do require an expense or trouble too great for general purposes, the society will not consider itself as bound to give the offered reward; but though it thus reserves the power of giving, in all cases, such part only of any premium as the performance shall be adjudged to deserve, or of withholding the whole, if there be no merit; yet the candidates may be assured, the society will always judge liberally of their several claims." The society requires that the subjects, offered for obtaining the premiums, should be delivered at their house without the names of the inventors or improvers, or any intimation by which they may be discovered, and that each subject thus offered shall have some private mark affixed, which mark must appear upon the outside of a sealed paper, containing within the claimant's name and address, to be delivered with the model, machine, &c. and they very properly refuse to perform their part of this liberal compact, unless the candidate literally complies with these judicious and necessary rules to preserve the strictest impartiality.

The society open no papers except that corresponding to the mark which obtains a premium, unless it should in some case become necessary for the determination of the claim; the remainder of the papers are returned with the articles they belong to, if inquired after by the mark within two years; should they not be demanded at the close of that period, they are publicly burnt, in the state in which they were sent, during the sitting of the society. The models that are considered worthy of a premium, or bounty, become the property of the Society, and when either is granted for a machine, the party receiving it is expected to present the Institution with a perfect model. As it cannot be expected that the funds of the society

should amount to a sum equal to the claims of very numerous applicants, its bounties are necessarily confined to the residents of Great Britain and Ireland, except an express intimation to the contrary occurs; nor can any person receive a premium who has obtained a patent for his discovery or improvement; besides, every person claiming is expected to act in the same open and ingenuous manner adopted by the society, for should he be detected in any unfair attempts to secure success, he not only forfeits all pretensions for the time, but is rendered incapable of future application.

The performances sent each year, which have obtained rewards, are left in the possession of the institution till after the public distribution of them, but no member can be a candidate for any thing more than the honorary medal of the society. "The candidates are, in all cases, expected to furnish a particular account of the subject of their claims; and where certificates are required to be produced in claim of premiums, they are to be expressed as clearly as possible in the words of the respective advertisements, and to be signed by persons who have a positive knowledge of the facts stated. Where premiums or bounties are obtained, in consequence of specimens produced, the society retains such part of those specimens as it judges necessary; at the same time, making reasonable compensation to the party concerned, who cannot be admitted to any of the meetings of the society, or its committees, or at their rooms, after they have delivered their claims, unless they are summoned by the latter. The stated periods for distributing the rewards produce a most interesting series of spectacles, which are not perhaps equalled by the operations of any other society.

Were we to follow the subject of this article to the extent it deserves, we should enter into an account of the

SOCIETY *for the relief of persons confined for small debts*, which originated in the benevolent mind of Dr. Dodd, and has been continued to the present moment with great success: and of the

SOCIETY, *Royal Humane, for the recovery of persons from supposed death*, and of various others under different denominations, exclusive of the

SOCIETIES, *benefit*, which have recently, under the authority of an act of parliament, been established throughout the kingdom; and which deserve every possible encouragement, as by their operation the poorest labourer may, by the weekly deposit of a very small portion of his earnings, assist in forming a fund that will, in the event of illness, afford him every comfort, and a decent funeral should it prove fatal.

Several most respectable and laudable societies have lately been founded, as the London Institution, the Surry Institution, the Russell Institution, and the Royal Institution; of the Royal and London Institutions we shall proceed to give some account.

ROYAL INSTITUTION. The immediate origin of this important society will be best explained by the following short extract from a letter written by Count Rumford, in 1799, to the Committee of the society, for "bettering the condition of the poor." "Inclosed I have the honour to send you a corrected copy of the proposals I took the liberty of laying before you on Thursday last, for forming in this capital, by private subscription, a public institution for diffusing the knowledge, and facilitating the general and speedy introduction of new and useful mechanical inventions and improvements; and also for teaching, by regular courses of philosophical lectures and experiments, the application of the new discoveries in science, to the improvement of arts and manufactures, and in facilitating the means of procuring the comforts and conveniencies of life."

The Committee made use of the first opportunity of communicating the above proposal to the society of which they were the acting members; the society immediately appointed a new Committee to confer with the Count, and they reported, "that they were satisfied that the institution proposed by him would be extremely beneficial and interesting to the community;" and they recommended that, in order to procure the necessary sum of money for establishing it, subscribers of fifty guineas each should become perpetual proprietors of the new institution; and that each of those persons should have perpetual transferable tickets for the lectures, besides admission to the apartments; further proposing, that when thirty such subscribers were obtained they should be invited to meet to receive the plan, and elect managers for the future proceedings. This report was favourably received and adopted, and a paper was immediately printed, explaining the proposed institution, and inviting those to whom it was communicated to become subscribers on the above terms; fifty-eight names were instantly procured, of the highest respect-

ability, the usual measures were pursued in order to give permanency and consequence to the undertaking, they were completely successful, and we now find it flourishing under the royal sanction, an honour to the nation and inventor, to whom we should be highly ungrateful did we omit to give an outline of his original plan, which must of course be the basis of all present and future operations.

Spacious and airy rooms he considered absolutely necessary for the reception and exhibition of mechanical inventions and improvements, and those are to be confined to such as tend to increase the conveniencies and comforts of life, to establish domestic economy, improve taste, and useful industry, and in order to promote this part of the views of the institution to the utmost, he purposed that the best models should be procured and shown in action, or actual use, of cottage fire-places, and kitchen utensils for cottagers, a complete kitchen for a farm house, with all the necessary utensils; a complete kitchen, with the utensils for the family of a man of fortune, a complete laundry for a gentleman's family, and a public hospital, including all the usual apparatus, Russian, Swedish, and German stoves; open fire-places, on the best principles, with fires in them, ornamental and economical grates, stoves in elegant forms, for halls, drawing and eating rooms, &c. He next proposed to exhibit working models of the steam-engine, on a reduced scale, and of all the varieties of boilers for manufactories, hospitals, and ships, with improved fire places, models of ventilators for rooms and ships, models of hot-houses, of lime-kilns, of boilers, steam-boilers, &c. for preparing food for cattle stall-fed, of cottages, spinning wheels, and looms, calculated for the advantage of the poor, or any other machinery to employ them at home; models of all newly invented machines and implements likely to become beneficial in husbandry, models of variously constructed bridges, and any others which the managers may hereafter deem worthy of a place in so extensive a collection: that this part of the establishment may be rendered as useful as possible, the Count proposed that illustrative drawings should accompany the models, &c. with a written description, and the prices affixed at which the articles may be procured.

The second object of the institution is the teaching the application of science to the useful purposes of life; for this branch a lecture room was to be provided, which might serve at the same time for philosophical experiments, with a complete laboratory and philosophical apparatus, the room he wished to contain convenient places for the subscribers, which he recommends should be well warmed and perfectly ventilated; the lecturers to be chosen by the managers, with the utmost circumspection, that none but men of eminence, in their respective pursuits, should officiate in that most important and most distinguished situation; and, he adds, "no subjects will ever be permitted to be discussed at these lectures but such as are strictly scientifical, and immediately connected with that particular branch of science, publicly announced, as the subject of the lecture." Persons, by his plan, are to be permitted to attend the lectures on being recommended by a subscriber, and paying a small sum. The subject of the lectures he proposed should be on the application of heat to the various purposes of life; the combustion of inflammable bodies, and the relative quantities of heat producible by the different substances used as fuel, the management of fire, and the economy of fuel, the principles of the warmth of clothing, the effects of heat and cold, and of winds of each description on the human body, in health and illness; the effects of vitiated air, the means of rendering dwelling-houses healthy and comfortable; the procuring and preserving of ice, and construction of ice-houses; preserving food in different seasons and climates, cooling fluids without the assistance of ice; on vegetation, and of the specific nature of those that are produced by manures; of composing the latter, and adapting it to particular soils; the nature of those changes that are produced on substances used as food, and of that which takes place in its digestion; the chemical principles of tanning hides, and their improvement; the chemical principles of the art of making soap, of the art of bleaching, dying, and, in general, of all the mechanical arts, as they apply to the various branches of manufacture.

At the first meeting of the managers, held at the house of Sir Joseph Banks, March 9, 1799, when that gentleman presided, it was proposed and resolved, "that the proposals for forming the institution, as published by Count Rumford, be approved and adopted by the managers; subject, however, to such partial modifications as shall be by them found to be necessary or useful."

A Committee of Managers, chosen by

ballot from the proprietors, direct and govern all the concerns of the institution; the three first of whom serve three years, the second two years, and the third one year; the whole nine being eligible for re-election, as no emolument whatever accrues to the managers, they are considered as having pledged their honour to preserve the establishment inviolate; they are required to insure the effects under their care from fire; to keep an exact account of all the property, of the receipts and expenditure, and minutes of all their proceedings; besides preserving the utmost order, and exercising the strictest economy in all their pecuniary arts; and they are forbidden to give premiums, or rewards, to those who invent any things useful, the design of the institution being exclusively for improvement and the diffusion of knowledge.

A Committee of Visitors, selected from the proprietors, totally distinct from the managers, are appointed to inspect the proceedings of the latter. Such is the Royal Institution; from which we shall now turn our attention to the

London Institution, *for the advancement of Literature and the diffusion of useful Knowledge.* The original object of the promoters of this undertaking was the acquisition of an extensive and valuable library, to diffuse useful knowledge by the means of lectures and experiments, and to establish a reading room for the reception and use of foreign and domestic journals, periodical works, pamphlets, and new publications. Having accomplished this, procured a charter, and fairly set the machine in motion, the following regulations were adopted: all the concerns of the institution are governed by a Committee of Managers, composed of the President, four Vice Presidents, twenty Managers, and the Secretary, who are chosen by and from the proprietors, one fourth of whom vacate their offices annually, but may be re-elected. A Committee of Visitors, consisting of the President and twelve other persons, none of whom are managers, elected by the proprietors from their own body, one fourth vacating their offices, as in the case of the managers, have authority to examine, at any time, every department of the institution, making their report, at their own option, either to the Committee of Managers, or Court of Proprietors; and five of those concurring in the propriety of the measure, may convene a special general meeting of the proprietors, after giving eight days previous notice.

An annual meeting is held in April, when five auditors are appointed by and from the proprietors, who are to examine the accounts of the institution, and prepare a report to be printed, and presented to each proprietor previous to the next annual meeting; and at this meeting the election of the president, one vice-president, five managers, three visitors, the treasurer, and secretary, takes place. The president, or a vice-president, takes the chair; but if neither should happen to be present, a manager is to preside: the secretary makes minutes of the proceedings, which are read at the next meeting, and if then approved of as correct, are to be signed by the president, or chairman: notice is given eight days before the meeting in four of the morning papers, and papers for the intended ballot are prepared at the house of the institution: many other regulations are established on this head, and for calling special meetings, which are highly useful and proper, but are too long for this article. The managers are empowered to engage professors and lecturers, who are to enter into courses on experimental philosophy, chemistry, and on the different departments of literature and the arts, which are to be given annually, or more frequently if thought proper, at the rooms of the establishment, at which time the managers are required to be careful that no other subjects are treated of except such as are decidedly connected with the objects of it. The managers are besides to elect and appoint annually, or otherwise, the professors, lecturers, librarians, the assistant secretaries, and other officers, who are subject to their control, and may be dismissed by them; and they have the same powers with all the domestic servants of the institution; they also direct all the affairs of the house, and make such regulations for it as they may think proper; appoint a superintendant of the inferior officers, and their expenses; and may permit such attendants as they please to reside in the house. The managers are required to keep registers of all their receipts and payments, their own transactions, and those of their agents, &c. which, with the necessary vouchers, are to be completed to the 31st of December annually, and laid before the auditors by the 25th of March following. They have additional powers to admit foreigners of high rank, or of distinguished scientific acquire-

ments, to the lectures, library, and other rooms of the establishment. Their meetings must be held in the house, nor can any business be transacted by them unless three members at least are present. Those meetings are monthly; and special meetings may be called on the requisition of the president, or two vice-presidents, or any three managers; the president, a vice-president, or a manager, may preside on each of these occasions; and the president, or chairman, is allowed a double vote when an equal division takes place on a question.

The visitors cannot act unless three are assembled; and they meet in March, June, September, and December; but other special meetings of them may be convened: they are to elect from their own body a secretary, who is to make minutes of their proceedings, but his office is entirely honorary.

The number of proprietors is limited at present to 1000: after the charter was obtained, the sum to be demanded of such is 100 guineas; and the method observed in supplying the vacancies hitherto, has been by vesting that power in the temporary committee of managers, who deliberately add to the list persons whose merit and abilities are likely to prove advantageous to the institution; their qualification, however, is but seventy-five guineas. A candidate for this honour must be proposed by a manager at the monthly meeting of that body; the name is suspended in the room for one month, when a ballot takes place, and a majority of two thirds is required in favour of the admission: after he has thus become a proprietor, he is entitled to his certificate, the printed catalogue, other papers of the institution, and tickets of admission, free of any further expense.

The property of the institution is exclusively vested in the proprietors, who, in their collective state, are enabled to dispose of it; consequently no sale, mortgage, or any kind or manner of involving its interests, can possibly occur, unless by consent of the whole. In return for this, they, and the subscribers and honorary members, have the common right of admission to the lectures, library, and reading rooms, &c. &c. every day, and at all hours, from eight o'clock in the morning till eleven at night, with the usual exceptions of Sundays, holidays, and Saturdays, when the doors are closed at three o'clock in the afternoon; the proprietors have, besides, one transferrable ticket each, which admits to the places already enumerated. A proprietor, who may be desirous of transferring his right in the institution, must inform the committee of managers of the name and residence of the intended purchaser in writing, who is balloted for at their next meeting, unless the transfer should be to the possessor's son, who is admitted without that ceremony: if the person should be rejected, another may be proposed: and if he also should be disapproved of, the proprietor wishing to sell may claim from the funds of the institution such sum as may then be fixed in the bye-laws as the qualification of a proprietor. Upon the decease of a proprietor, his executors may proceed, with some little variation, in the same manner prescribed for the sale of a proprietorship.

Persons of rank and superior qualifications, both natives and foreigners, may be elected honorary members; but two negatives will exclude them upon the ballot. The rights of life and annual subscribers necessarily extend no further than to the use of the rooms and library, nor can they be admitted such without the ceremony of proposing and electing. Subscribers to the library, or to particular courses of lectures, are admitted upon terms fixed by the managers, who also admit ladies in the same way, but to the lectures only.

A meeting of the proprietors was held in October, 1805, when it was resolved, that the sum of 40,000*l.* should as speedily as possible be invested in the funds, in order that a permanent basis might be founded to secure the success of the institution; other sums were at the same time directed to be placed in floating public securities, to be disposed of when the produce should be wanted. The rents, revenues, and annual income, to be applied for rent, taxes, salaries, repairs, &c. &c. and in purchasing foreign and domestic journals, periodical and other new works, for the use of the reading room: the surplus beyond these purposes was directed by the meeting to be used for augmenting the library and the philosophical apparatus.

We shall conclude our account of this excellent institution in the words of the rules for the use of the library. "No person shall take down any of the books in the library; but a note or card, containing the name of the person applying, and the title of the book, must be given to the librarian, or attendant, who shall supply him with the book required. No person shall take away any book belonging to the library." A

manuscript catalogue is kept for the subscribers in the room; but a printed one is hereafter to be prepared and delivered. "No librarian, or attendant, or any other officer or servant of the institution, shall receive any fee, perquisite, or gratuity, on account of, or during the execution of their office, under penalty of immediate dismission from the service of the institution."

SOCMEN, or SOKEMEN, such tenants as held their lands and tenements in socage; but the tenants in ancient demesne, seem most properly to be called socmans.

SOCRATIC *philosophy*, the doctrines and opinions, with regard to morality and religion, maintained and taught by Socrates. By the character of Socrates, left us by the ancients, particularly by his scholar Plato, Laertius, &c. he appears to have been one of the best and the wisest persons in all the heathen world. To him is ascribed the first introduction of moral philosophy, which is what is meant by that usual saying, "that Socrates first called philosophy down from heaven to earth;" that is, from the contemplation of the heavens and heavenly bodies, he led men to consider themselves, their own passions, opinions, faculties, duties, actions, &c. He wrote nothing himself, yet all the Grecian sects of philosophers refer their origin to his discipline, particularly the Platonists, Peripatetics, Academics, Cyrenaics, Stoics, &c. but the greatest part of his philosophy we have in the works of Plato.

SODA, in mineralogy and chemistry, is a species of fossil salts, divided by mineralogists into common and radiated natron. Common natron is of a yellowish grey colour; it occurs in fine flakes, or in dusty particles; it has a sharp alkaline taste; effervesces with nitric acid; is easily soluble in water, and its solution changes blue vegetable tinctures to a green; it is fusible before the blow-pipe. It is found either as an efflorescence on the surface of the soil; or on decomposing certain rocks; or on the sides and bottoms of lakes, that become dry by the heat and drought of summer. It is obtained in great abundance in many parts of Germany, and also in Egypt. That from Egypt has, according to Klaproth, yielded to analysis the following substances:

Carbonate of soda	32.6
Sulphate of soda	20.8
Muriate of soda	15.0
Water	31.6
	100.0

The radiated natron is of a yellowish grey colour: it occurs in crusts, and in capillary or acicular crystals, which are aggregated on one another; it is glistening and translucent. This is found native about two days journey from Fezzan, at the bottom of a rocky mountain, forming crusts, usually the thickness of a knife, and sometimes even an inch thick on the surface of the earth. It is always crystalline. Besides the great quantity carried to Egypt and other parts, there are said to be fifty tons annually sent to Tripoli. It is not adulterated with salt. Though there is abundance of salt in this part of Africa, it must be observed that the salt mines are situated on the sea coast, whereas the radiated natron, called trona, occurs at the distance of twenty-eight days journey up the country. It is principally employed in the manufacture of glass and soap, and also for the washing of linen. This species has been analyzed by Klaproth, and found to consist of

Sulphate of soda	2.5
Pure soda	37.0
Carbonic acid	38.0
Water of crystallization......	22.5
	100.0

Soda was long regarded as a simple body; it has, however, at length been decomposed by Mr. Davy. See the article POTASH, where a brief account is given of the discovery.

SOFFITA, or SOFFIT, in architecture, any plafond, or ceiling, formed of cross beams of flying corniches, the square compartiments or pannels of which are enriched with sculpture, painting, or gilding.

SOHO, the name of a set of works, or manufactory of a variety of hard wares belonging to Mr. Boulton, situated on the borders of Staffordshire, within two miles of Birmingham, now so justly celebrated as to claim a short notice in this place. About thirty or forty years ago the premises consisted of a small mill and a few obscure dwellings. Mr. Boulton, in conjunction with Mr. Fothergill, then his partner, at an expense of nine thousand pounds, erected a handsome and extensive edifice, with a view of manufacturing metallic toys. The first productions consisted of buttons, buckles, watch-chains, trinkets, and such other articles as were peculiar to Birmingham. Novelty, taste, and variety were, however, always conspicuous; and plated wares,

known by the name of Sheffield plate, comprising a great variety of useful and ornamental articles, became another permanent subject of manufacture. To open channels for the consumption of these commodities, all the northern part of Europe was explored by the mercantile partner, Mr. Fothergill. A wide and extensive correspondence was thus established, the undertaking became well known, and the manufacturer, by becoming his own merchant, eventually enjoyed a double profit. Impelled by an ardent attachment to the arts, and by the patriotic ambition of forming his favourite Soho into a fruitful seminary of artists, the proprietor extended his views, and men of taste and talents were now sought for and liberally patronised. A successful imitation of the French or moulic ornaments, consisting of vases, tripods, candelabra, &c. &c. extended the celebrity of the works. Services of plate, and other works in silver, both massive and airy, were added, and an assay office was established in Birmingham. Mr. Watt, the ingenious improver of the steam engine, is now in partnership with Mr. Boulton, and they carry on at Soho a manufactory of steam-engines, not less beneficial to the public than lucrative to themselves. This valuable machine, the nature and excellencies of which are described in another place, (see STEAM-ENGINE). Mr. Boulton has applied to the operation of coining; and to the rolling of iron from bars into thin sheets; to the purposes of button-making, and a number of other mechanical operations of the highest utility to the national wealth and prosperity.

SOIT FAIT COMME IL EST DESIRÉ, *be it done as it is desired*, a form used when the king gives the royal assent to a private bill preferred in parliament.

SOL, or SOU, a French coin made up of copper mixed with a little silver.

SOL, the *sun*, in astronomy, astrology, &c. See SUN.

SOL, in chemistry, is gold; thus called from an opinion that this metal is in a particular manner under the influence of the sun.

SOL, in heraldry, denotes *Or*, the golden colour in the arms of sovereign princes.

SOLANDRA, in botany, so named in honour of Daniel Charles Solander, a Swede, a genus of the Pentandria Monogynia class and order. Essential character: calyx bursting; corolla clavate, funnel form, very large; berry four-celled, many-seeded. There is but one species, viz. S. grandiflora, great flowered Solandra, a native of Jamaica.

SOLANUM, in botany, *nightshade*, a genus of the Pentandria Monogynia class and order. Natural order of Luridæ. Solaneæ, Jussieu. Essential character: corolla wheel-shaped; anthers subcoalescent, opening at top by a double pore; berry two-celled. There are ninety-three species, of which the following are the most remarkable. S. dulcamora, woody nightshade, a native of Britain and of Africa, is a slender climbing plant, rising to six or more feet in height. The leaves are generally oval, pointed, and of a deep-green colour; the flowers hang in loose clusters, of a purple colour, and divided into five pointed segments. It grows in hedges well supplied with water, and flowers about the end of June. On chewing the roots, we first feel a bitter, then a sweet taste; hence the name. The berries are said to be poisonous, and may easily be mistaken by children for currants. The younger branches are directed for use, and may be employed either fresh or dried; they should be gathered in the autumn. This plant is generally given in decoction or infusion. Several authors take notice, that the dulcamora partakes of the milder powers of the nightshade, joined to a resolvent and saponaceous quality. S. nigrum, garden nightshade, common in many places in Britain about dunghills and waste places. It rises to about two feet in height. The stalk herbaceous; the leaves alternate, irregularly oval, indented, and clothed with soft hairs. The flowers are white; the berries black and shining. It appears to possess the deleterious qualities of the other nightshades in a very high degree, and even the smell of the plant is said to cause sleep. The berries are equally poisonous with the leaves, causing cardialgia and delirium, and violent distortions of the limbs in children. In ancient times it was employed externally as a discutient and anodyne in some cutaneous affections, tumefactions of the glands, ulcers, and disorders of the eyes. A variety of the solanum nigrum, a native of the West Indies, is called guma by the negroes. It is so far from having any deleterious quality, that it is daily served up at table as greens or spinach. It has an agreeable bitter taste. S. lycopersicum, the love-apple, or tomato, is cultivated in gardens in the warmer parts of Europe, and in all tropical countries. The stalk is herbaceous: the leaves pinnated, oval, pointed, and deeply

divided. The flowers are on simple racemi; they are small and yellow. The berry is of the size of a plum: they are smooth, shining, soft; and are either of a yellow or reddish colour.

S. tuberosum, or common potatoe, is a species of this genus; which is too well known to require description.

SOLAR, something belonging to the sun; thus the solar system is that system of the world wherein the heavenly bodies are made to revolve round the sun as the centre of their motion. Also the solar year is that consisting of three hundred and sixty-five days, five hours, and forty-nine minutes, in opposition to the lunar year, consisting of three hundred and fifty-four days.

SOLDANELLA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Preciæ. Lysimachiæ, Jussieu. Essential character: corolla bell-shaped, lacero multifid; capsule one-celled, many-toothed at the top. There is only one species, *viz.* S. alpina, Alpine soldanella.

SOLDER, SODDER, or SODER, a metallic or mineral composition used in soldering, or joining together, other metals. See the next article. Solders are made of gold, silver, copper, tin, bismuth, and lead; usually observing, that in the composition there be some of the metal that is to be soldered mixed with some higher and finer metals. Goldsmiths usually make four kinds of solder, *viz.* solder of eight, where to seven parts of silver there is one of brass or copper; solder of six, where only a sixth part is copper; solder of four, and solder of three. It is the mixture of copper in the solder that makes raised plate come always cheaper than flat. The solder used by plumbers is made of two pounds of lead to one of block-tin. Its goodness is tried by melting it and pouring the bigness of a crown-piece upon a table; for if good, there will arise little bright shining stars therein. The solder for copper is made like that of the plumbers, only with copper and tin; for very nice works, instead of tin they sometimes use a quantity of silver. Solder for tin is made of two thirds of tin and one of lead; but where the work is any thing delicate, as in organ pipes, where the juncture is scarce discernible, it is made of one part of bismuth and three parts of pewter.

SOLDERING, among mechanics, the joining and fastening together two pieces of the same metal, or of two different metals, by the fusion and application of some metalic composition on the extremities of the metals to be joined.

SOLE, in natural history. See PLEURONECTES.

SOLECISM, in grammar, a false manner of speaking contrary to the use of language and the rules of grammar, either in respect of declension, conjugation, or syntax.

SOLEN, in natural history, *razor-sheath*, a genus of the Vermes Testacea class and order. Animal an ascidia; shell bivalve, oblong, open at both ends; hinge with a subulate reflected tooth, often double, and not inserted in the opposite valve. There are about twenty-four species, some whereof are straight, others crooked, some red, others variegated with brown and blue, some brown and white, others of a violet-purple colour. This last is a beautiful smooth shell, from three to six inches long, and from one-third to three quarters of an inch in diameter. There is also another not inelegant species, variegated with brown and blue, and a little arcuated. The S. anatinus has the shell ovate, membranaceous, hairy, with a falcate rib at the hinge; the shell is pellucid, white, thin like paper; one end rounded and closed, the other gaping like the beak of a bird; tooth in each valve resembling an ear-picker.

SOLID, in philosophy, a body whose parts are so firmly connected together, as not to give way, or slip from each other upon the smallest impression; in which sense solid stands opposed to fluid. Geometricians define a solid to be the third species of magnitude, or that which has three dimensions, *viz.* length, breadth, and thickness or depth. A solid may be conceived to be formed by the revolution, or direct motion, of a superficies of any figure whatever, and is always terminated or contained under one or more planes or surfaces, as a surface is under one or more lines.

Solids are commonly divided into regular and irregular. The regular solids are those terminated by regular and equal planes, and are only five in number, *viz.* the tetrahedron, which consists of four equal triangles; the cube, or hexahedron, of six equal squares; the octahedron, of eight equal triangles; the dodecahedron, of twelve; and the icosihedron, of twenty equal triangles. The irregular solids are almost infinite, comprehending all such as do not come under the definition of regular solids; as the sphere,

cylinder, cone, parallelogram, prism, parallelopiped, &c.

Solid *numbers*, are those which arise from the multiplication of a plane number, by any other whatsoever; as 18 is a solid number made of 6 (which is plane) multiplied by 3; or of 9 multiplied by 2.

Solid *problem*, in mathematics, is one which cannot be geometrically solved unless by the intersection of a circle and a conic section; or by the intersection of two other conic sections, besides the circle. As to describe an isosceles triangle on a given right line, whose angle at the base shall be triple to that at the vertex. This will help to inscribe a regular heptagon in a given circle; and may be resolved by the intersection of a parabola, and a circle. This problem also helps to inscribe a nonagon in a circle, and may be solved by the intersection of a parabola, and an hyperbola between its asymptotes, *viz.* to describe an isosceles triangle, whose angle at the base shall be quadruple of that at the vertex. And such a problem as this hath four solutions, and no more; because two conic sections can cut one another but in four points.

SOLIDAGO, in botany, *golden rod*, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx scales imbricate, closed; corollets of the ray about five; seed down simple, receptacle naked. There are thirty species. The golden rods are natives of North America, excepting two species, which are found in Europe, and two others which were discovered by Houston in New Spain, and have not been adopted by Linnæus or any other author.

SOLIDITY, that property of matter, or body, by which it excludes all other bodies from the place which itself possesses: and as it would be absurd to suppose that two bodies could possess one and the same place at the same time, it follows, that the softest bodies are equally solid with the hardest. Among geometricians the solidity of a body denotes the quantity or space contained in it, and is called also its solid content.

Solidity, in architecture, is applied both to the consistence of the ground, whereon the foundation of a building is laid; and to a massive in masonry, of extraordinary thickness, without any cavity within.

SOLSTICE, in astronomy, that time when the Sun is in one of the solstitial points; that is, when he is at his greatest distance from the equator, thus called, because he then appears to stand still, and not to change his distance from the equator for some time; an appearance owing to the obliquity of our sphere, and which those living under the equator are strangers to. The solstices are two in each year, the æstival, or summer solstice; and the hyemal, or winter solstice. The summer solstice is when the Sun seems to describe the tropic of Cancer, which is on June 22, when he makes the longest day; the winter solstice is when the Sun enters the first degree, or seems to describe the tropic of Capricorn, which is on December 22, when he makes the shortest day. This is to be understood as in our northern hemisphere; for in the southern the Sun's entrance into Capricorn makes the summer solstice, and that into Cancer the winter solstice. The two points of the ecliptic, wherein the Sun's greatest ascent above the equator, and his descent below it, are terminated, are called the solstitial points; and a circle, supposed to pass through the poles of the world and these points, is called the solstitial colure. The summer solstitial point is in the beginning of the first degree of Cancer, and is called the æstival, or summer point; and the winter solstitial point is in the beginning of the first degree of Capricorn, and is called the winter point. These two points are diametrically opposite to each other.

SOLUM *plantarum*, in botany and gardening, the natural soil of plants, or that which is best adapted to their growth. In the culture, therefore, of plants, it is of importance to have a distinct knowledge of those kinds of soil which are adapted to the several genera and species.

SOLUTION, in chemistry, is the perfect union of a solid substance with a fluid, so as apparently to form one homogeneous liquid. The fluid is termed the solvent, or menstruum. A solution is distinguished from a mixture by being perfectly clear, and from the particles of the solid not separating from the mass when remaining at rest.

SOMMETI, a mineral named from the mountain Somma, where it was first found. It is usually mixed with volcanic productions. It crystallizes in prisms, sometimes terminated by pyramids. Colour white, and somewhat transparent. It cuts glass. The specific gravity is 3.27. Infusible by

the blow-pipe; and according to Vauquelin, it is composed of

Alumina	49
Silica	46
Lime	2
Oxide of iron	1
	98
Loss	2
	100

SONCHUS, in botany, *sow-thistle*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semiflosculosæ. Cichboraceæ, Jussieu. Essential character: calyx imbricate, ventricose; down hairy; receptacle naked. There are nineteen species.

SONG, in poetry, a little composition, consisting of easy and natural verses, set to a tune in order to be sung.

SONG *of birds*. The song of birds has been defined to be a succession of three or four different notes, which are continued without interruption through the same intervals, in a bar of four crotchets, adagio, or while a pendulum swings four seconds. It is observed, that notes in birds are no more innate than language in man, and that they depend entirely on the master under which they are bred, as far as their organs will enable them to imitate the sounds which they have frequent opportunities of hearing; and their adhering so steadily, even in a wild state, to the same song, is entirely owing to the nestlings attending only to the instruction of the parent-bird, whilst they disregard the notes of all others that may perhaps be singing round them. Birds in a wild state do not commonly sing more than six or seven months out of the twelve; but birds that are caged and have plenty of food sing the greatest part of the year; and we may add, that the female of no species of birds ever sings. It has been remarked, that there is no instance of any bird singing whose size exceeds that of our blackbird; and this is supposed to arise from the difficulty it would have of concealing itself, did it call the attention of its enemies, not only by its bulk, but by the proportionable loudness of its notes. It has been noticed by some writers, that certain passages of the song in a few kinds of birds correspond with the intervals of our scale, of which indeed the cuckoo affords a striking and well known instance; but much the greater part of such song is not capable of musical notation; partly because the rapidity is often so great, and it is also so uncertain when they may stop, that we cannot reduce the passages to the form of any musical bar whatsoever; partly also because the pitch of most birds is considerably higher than that of the shrillest notes of our highest instruments; and principally because the intervals used by birds are commonly so minute, and consequently so different from the more gross intervals into which we divide our octave, that we cannot judge of them. Most people, who have not attended to the notes of birds, suppose that all those of the same species sing exactly the same notes and passages, which is by no means true, though it must be admitted that there is a general resemblance. Thus the London bird-catchers prefer the song of the Kentish goldfinches, and Essex chaffinches; but some of the nightingale-fanciers prefer a Surry bird to one of Middlesex. The nightingale has been almost universally esteemed the most capital of singing birds; and its superiority chiefly consists in the following particulars: its tone is much more mellow than that of any other bird, though by the exertion of its powers it can be extremely brilliant. Another point of superiority is its continuance of song without a pause, which is often extended to twenty seconds.

SONG, in music, is applied in general to a single piece of music, whether contrived for the voice or an instrument. A song has been compared to an oration; for as, in this latter, there is a subject, *viz.* some person or thing the discourse is referred to, and which is always to be kept in view through the whole; so, in every regular and melodious song, there is one note which regulates the rest; wherein the song begins, and at last ends; and which is, as it were, the principal matter, or musical subject, to be regarded in the whole course of the song; and this principal or fundamental note is called the key of the song.

SONNERATIA, in botany, so named in memory of Mons. Sonnerat, a genus of the Icosandria Monogynia class and order. Natural order of Hesperideæ. Myrti, Jussieu. Essential character: calyx six-cleft; petals six, lanceolate; berry many-celled, with several seeds in each cell. There is but one species, *viz.* S. acida, a native of the Molucca islands, and the bogs of New Guinea; also of Cochin China, on the banks of rivers.

SOOT, a volatile matter, arising from wood, and other fuel, along with the

smoke; or rather, it is the smoke itself, fixed and gathered on the sides of the chimney.

SOPHISM, in logic, &c. an argument which carries much of the appearance of truth, and yet leads into error. There is some need of a particular description of these fallacious arguments, that we may with more ease and readiness detect and solve them. 1 The first sort of sophism is called "ignoratio elenchi," or a mistake of the question. 2. The next sophism is called "petitio principii," or a supposition of what is not granted. 3. That sort of fallacy which is called a circle, is very near a-kin to the "petitio principii." 4. The next sort of sophism is called "non causa pro causa," or the assignation of a false cause. 5. The next is called "fallacia accidentis," or a sophism, wherein we pronounce concerning the nature and essential properties of any subject, according to something which is merely accidental to it. 6. The next sophism borders upon the former, and that is when we argue from that which is true, absolutely, simply, and abstracted from all circumstances. this is called, in the schools, a sophism "a dicto secundum quid ad dictum simpliciter." This sort of sophism has also its reverse, as, when we argue from that which is true, simply and absolutely, to prove the same thing true in all particular circumstances whatsoever. 7. The sophisms of composition and division come next to be mentioned. The sophism of composition is, when we infer any thing concerning ideas in a compound sense, which is only true in a divided sense. The sophism of division is, when we infer the same thing concerning ideas in a divided sense, which is only true in a compounded one. This sort of sophism is committed when the word *all* is taken in a collective and distributive sense, without a due distinction. It is the same fallacy, when the universal word *all*, or *no*, refers to species in one proposition, and to the individuals in another. 8. The last sort of sophisms arises from our abuse of the ambiguity of words, which is the largest and most extensive kind of fallacy. and, indeed, several of the former fallacies might be reduced to this head When the words or phrases are plainly equivocal, they are called sophisms of equivocation. This sophism, as well as the foregoing, and all of the like nature, are solved by showing the different senses of the words, terms, or phrases.

But, where such gross equivocations and ambiguities appear in arguments, there is little danger in imposing on ourselves or others. the greatest danger, and what we are perpetually exposed to, in reasoning, is, where the two senses or significations of one term are near a-kin, and not plainly distinguished, and yet are sufficiently different in their sense to lead us into great mistakes, if we are not watchful. And, indeed, the greatest part of controversies, in the sacred or civil life, arise from the different senses that are put upon words, and the different ideas conveyed by them.

SOPHORA, in botany, a genus of the Decandria Monogynia class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: calyx five-toothed, gibbous above, corolla papilionaceous, with the wings of the same length with the standard, legume. There are twenty-five species.

SORBUS, in botany, *mountain-ash*, a genus of the Icosandria Trigynia class and order. Natural order of Pomaceæ. Rosaceæ, Jussieu. Essential character: calyx five-cleft, petals five; berry inferior, three-seeded. There are three species.

SOREX, the *shrew*, in natural history, a genus of Mammalia of the order Feræ. Generic character: in the upper jaw two front teeth long and bifid; in the lower two or four, the intermediate ones shorter; several tusks on each side; grinders cuspidated. This genus of animals is most nearly allied to that of the mouse. Its teeth, however, constitute an important variation, and class it rather with the carnivorous tribes. There are seventeen species, of which the following most deserve attention. S. araneus, or the fetid shrew, is found throughout Europe and the north of Asia, and inhabits fields, gardens, and outhouses, and measures about two inches and a half in length, exclusively of its tail. It is distinguished from a mouse chiefly by a long and sharp snout. It breeds in holes under banks, feeds on roots and grain, as well as on every species of putrid animal substance, and has a very rank and disagreeable odour, whence it derives its designation.

S. moschatus, or the musky shrew, abounds in the north of Europe and Asia, and inhabits principally the river Volga, rarely appearing on land. It is about seven inches long, to the tail, and of a cinereous brown colour. Its snout is extremely prolonged, and apparently cartilaginous. It feeds on worms, water-insects, and leeches, and

sometimes on vegetables. These animals are often observed swimming on rivers and lakes in large companies. On land their motions are particularly slow. They are destroyed in Russia to be placed in drawers or chests, from which they effectually keep moths at a distance. See Mammalia, Plate XX. fig. 3.

S. radiatus, or the radiated shrew, is a native of Canada, and is remarkable for having on the extremity of its snout a circle of sharp pointed processes, somewhat like the radius of a boot-spur, for having its tail most curiously knotted, somewhat resembling what are called Queen's garters, and for having its feet with five toes, each covered with scales. It burrows like the mole, but is seen far more frequently above ground. See Mammalia, Plate XX. fig. 2.

S. cæruleus, or the perfuming shrew, is found in India, and is stated to leave an intolerable musky scent on every substance over which it passes, and it has been asserted by gentlemen of respectability, that a corked bottle of wine has been so completely penetrated by this effluvium, as totally to spoil the liquor. The great strength and subtlety of the perfume are, at all events, unquestionable. This animal prefers rice to almost all other food, living chiefly in the rice fields, but occasionally entering houses.

S. exilis, or the pygmy shrew, abounds in Siberia, is shaped and coloured like the common shrew, and is noticed here for being, probably the very smallest of European quadrupeds, being about half a dram only in weight. See Mammalia, Plate XX. fig. 1.

SORITES, in logic, a species of reasoning, in which a great number of propositions are so linked together, that the predicate of the one becomes continually the subject of the next following, till at last a conclusion is formed by bringing together the subject of the first proposition and the predicate of the last; such is the following argument, "God is omnipotent; an omnipotent being can do every thing possible; a being that can do every thing possible, can do whatever involves not a contradiction; therefore, God can do whatever involves not a contradiction." This combination of propositions may be continued to any length we please, without in the least weakening the ground upon which the conclusion rests; and the reason is, because the sorites may be resolved into as many simple syllogisms as there are middle terms in it; and the conclusion of the last syllogism is universally found to be the same with the conclusion of the sorites.

SOUND or, HEARING, *sense of*. The sense of sight is effected by rays of light, proceeding from the different objects to the retina. The sense of feeling is effected by the contact of its various objects with the body, or by the vigorous or unsound state of the parts of the body. The sense of taste is affected by certain particles of substances which are dissolved by the saliva, and thus brought into contact with the organs of taste. The sense of smell is affected by particles which various substances are continually sending into the air, and which impress the membrane which lines the cavity and bones of the nose. The sense of hearing is affected by the pulsations or vibrations of the air, which are caused by its own expansion, or by the vibrations of sounding bodies. These sensations, or vibrations in the air, are called sounds, as are also the sensations which they produce. The organ of hearing is much more complicated, and much less understood, than that of sight. We shall here give a very general account of it, and refer those who wish for further information to the article ANATOMY. The external ear collects and modifies sounds; and by a long channel communicates them to the internal ear: this consists, in the first place, of what is called the drum of the ear, which is a small cavity, closed towards the opening of the ear by a delicate membrane. In the drum are three or four very small bones, furnished with muscles, and joints. From the drum are several openings, one of which is to the mouth; the others communicate into the different recesses of the ear. One of these leads into the labyrinth, which consists first, of a small irregular cavity, next of three semicircular canals, and lastly of a winding spiral canal, not unlike some sea shells. All these parts of the cavity are lined with a very delicate membrane, and filled with a watery fluid, which conveys to the portions of the nerve in contact with it, the vibrations received from the membrane which separates the labyrinth from the drum of the ear. The vibrations of the air act upon the drum, and thus set in motion the series of small bones in the cavity of the drum; these communicate the vibrations to the membrane which separates the drum from the labyrinth, and this (as before mentioned) produces vibrations in the watery fluid, in the several parts of the

labyrinth, and conveys to the nervous branches, which line the labyrinth, the vibrations originally produced on the drum. The mechanism is complicated, but what we understand must increase our reverential admiration of the skill which produced it.

There are colours which of themselves, without associated ideas, are agreeable to the sight; so it is reasonable to believe, that there are sounds which of themselves, without associated ideas, are agreeable to the ear. This is authorised also by direct experience. All moderate and tolerably uniform sounds please young children; and during the whole of life, various combined and simple sounds give pleasure to the mind, without any reference to the associated ideas. Hence it appears that the pleasures of hearing aid considerably in the formation, or at least in the increase, of the mental pleasures: indeed, in connection with those of sight, they constitute nearly the whole of the pleasures of sublimity and beauty.

It is a well known fact, that the ideas left by the sensations of sight are the most vivid and distinct of any: next to these are those produced by the sensation of hearing. Few can form a distinct, certainly not a vivid, conception of the feel of any substance which has presented sensations through the medium of the touch, and not many more can of a taste, or of a smell, though thinking of particular taste produces a considerable effusion of the saliva. Of objects of the sight we are able to form conceptions, which often approach in vividness and distinctness to the original sensations, and which sometimes overpower those actually present in the mind, so as in many cases to lead to the belief of a real object, and consequently to lead to the belief of apparitions, &c. Few, we believe, possess the power of forming conceptions of sounds nearly equal in vividness and distinctness with the original sensation; but they are frequently perceptible. After we have heard music, or conversed much with a person, trains of audible ideas frequently pass in the mind. So, when we are thinking or reading slowly and carefully, we can generally trace the relicts of the audible impressions of the words suggested by the thoughts, or the sight of the letters; that is, we have faint conceptions of the sounds of these words.

The necessity of hearing to man, considered as a social being, is obvious, its importance to him, considered as a being whose pleasures and pains are by degrees to be purely mental, is not inferior. The means of knowledge are greatly diminished by the loss of sight; but the loss of sight only impedes the progress of the mind from sensation to thought and feeling. Those who have never heard have much greater disadvantages to undergo. Their deficiencies can never be fully supplied. Words, as Hartley suggests, are highly important, and even necessary, to the full improvement of intellect, and the enlargement of the affections; and therefore the ear is of much more importance to us, as spiritual beings, than the eye.

To illustrate the cause of sound, it is to be observed, 1st, That a motion is necessary in the sonorous body for the production of sound. 2dly, That this motion exists first in the small and insensible parts of the sonorous bodies, and is excited in them by their mutual collision against each other, which produces the tremulous motion so observable in bodies that have a clear sound, as bells, musical chords, &c. 3dly, That this motion is communicated to, or produces a like motion in the air, or such parts of it as are fit to receive and propagate it. Lastly, That this motion must be communicated to those parts that are the proper and immediate instruments of hearing. Now that motion of a sonorous body, which is the immediate cause of sound, may be owing to two different causes; either the percussion between it and other hard bodies, as in drums, bells, chords, &c. or the beating and dashing of the sonorous body and the air immediately against each other, as in flutes, trumpets, &c. But in both these cases, the motion, which is the consequence of the mutual action, as well as the immediate cause of the sonorous motion which the air conveys to the ear, is supposed to be an invisible, tremulous or undulating motion, in the small and insensible parts of the body.

The sonorous body having made its impression on the contiguous air, that impression is propagated from one particle to another, according to the laws of pneumatics. A few particles, for instance, driven from the surface of the body, push or press their adjacent particles into a less space; and the medium, as it is thus rarefied in one place, becomes condensed in the other; but the air thus compressed in the second place, is, by its elasticity, returned back again, both to its former place and its former state; and the air contiguous to that is

compressed; and the like obtains when the air less compressed, expanding itself, a new compression is generated. Therefore from each agitation of the air there arises a motion in it, analogous to the motion of a wave on the surface of the water, which is called a wave or undulation of air. In each wave, the particles go and return back again through very short equal spaces, the motion of each particle being analogous to the motion of a vibrating pendulum while it performs two oscillations, and most of the laws of the pendulum, with very little alteration, being applicable to the former.

Sounds are as various as are the means that concur in producing them. The chief varieties result from the figure, constitution, quantity, &c. of the sonorous body, the manner of percussion, with the velocity &c. of the consequent vibrations, the state and constitution of the medium; the disposition, distance, &c. of the organ: the obstacles between the organ and the sonorous object and the adjacent bodies. The most notable distinction of sounds, arising from the various degrees and combinations of the conditions above mentioned, are into loud and low (or strong and weak), into grave and acute (or sharp and flat, or high and low), and into long and short. The management of which is the office of music.

Euler is of opinion, that no sound making fewer vibrations than 30 in a second, or more than 7520, is distinguishable by the human ear. According to this doctrine, the limit of our hearing, as to acute and grave, is an interval of eight octaves. The velocity of sound is the same with that of the aerial waves, and does not vary much, whether it go with the wind or against it. By the wind indeed a certain quantity of air is carried from one place to another; and the sound is accelerated while its waves move through that part of the air, if their direction be the same as that of the wind. But as sound moves vastly swifter than the wind, the acceleration it will hereby receive is but inconsiderable; and the chief effect we can perceive from the wind is, that it increases and diminishes the space of the waves, so that by help of it the sound may be heard to a greater distance than otherwise it would.

That the air is the usual medium of sound, appears from various experiments in rarefied and condensed air. In an unexhausted receiver, a small bell may be heard to some distance; but when exhausted, it can scarce be heard at the smallest distance. When the air is condensed, the sound is louder in proportion to the condensation, or quantity of air crowded in; of which there are many instances in Hauksbee's experiments, in Dr. Priestley's, and others. Besides, sounding bodies communicate tremors to distant bodies, for example, the vibrating motion of a musical string puts others in motion, whose tension and quantity of matter dispose their vibrations to keep time with the pulses of air, propagated from the string that was struck. Galileo explains this phenomenon by observing, that a heavy pendulum may be put in motion by the least breath of the mouth, provided the blasts be often repeated, and keep time exactly with the vibrations of the pendulum, and also by the like art in raising a large bell.

It is not air alone that is capable of the impressions of sound, but water also, as is manifest by striking a bell under water, the sound of which may plainly enough be heard, only not so loud, and also a fourth deeper, according to good judges in musical notes. And Mersenne says, a sound made under water is of the same tone or note, as if made in air, and heard under the water. The velocity of sound, or the space through which it is propagated in a given time, has been very differently estimated by authors who have written concerning this subject. Roberval states it at the rate of 560 feet in a second; Gassendus at 1473, Mersenne at 1474, Duhamel, in the History of the Academy of Sciences at Paris, at 1338; Newton at 968, Derham, in whose measure Flamsteed and Halley acquiesce, at 1142. The reason of this variety is ascribed by Derham, partly to some of those gentlemen using strings and plummets instead of regular pendulums; and partly to the too small distance between the sonorous body and the place of observation; and partly to no regard being had to the winds. But by the account since published by M. Cassini de Thury, in the Memoirs of the Royal Academy of Sciences at Paris, 1738, where cannon were fired at various as well as great distances, under many varieties of weather, wind, and other circumstances, and where the measures of the different places had been settled with the utmost exactness, it was found that sound was propagated, on a medium, at the rate of 1038 French feet in a second of time. But the French foot is in proportion to the English as 15 to 16: and consequently 1038 French feet are equal to 1107

English feet. Therefore the difference of the measures of Derham and Cassini is 35 English feet, or 33 French feet, in a second. The medium velocity of sound therefore is nearly at the rate of a mile, or 5280 feet, in 4¾ seconds, or a league in 14 seconds, or 13 miles in a minute. But sea miles are to land miles nearly as 7 to 6, and therefore sound moves over a sea mile in 5½ seconds nearly, or a sea league in 16 seconds. Further, it is a common observation, that persons in good health have about 75 pulsations, or beats of the artery at the wrist, in a minute, consequently in 75 pulsations, sound flies about 13 land miles, or 11¼ sea miles, which is about 1 land mile in 6 pulses, or one sea mile in 7 pulses, or a league in 20 pulses. And hence the distance of objects may be found, by knowing the time employed by sound in moving from those objects to an observer. For example: On seeing the flash of a gun at sea, if 54 beats of the pulse at the wrist were counted before the report was heard; the distance of the gun will easily be found by dividing 54 by 20, which gives 2.7 leagues, or about 8 miles. See Acoustics.

Sound, in geography, denotes in general any streight, or inlet, of the sea, between two head lands. However, the name sound is given, by way of eminence, to the streight between Sweden and Denmark, joining the German Ocean to the Baltic, being about four miles over.

Sound *board*, in an organ, is a reservoir into which the wind, drawn in by the bellows, is conducted by a port-vent, and hence distributed into the pipes placed over holes in its upper part: this wind enters them by valves, which open by pressing upon the stops or keys, after drawing the registers, which prevent the air from entering any of the pipes, except those it is required in.

SOUNDING, the operation of trying the depth of the water, and the quality of the ground, by means of a plummet sunk from a ship to the bottom. For sounding there are two plummets used, one of which is called the hand lead, weighing about eight or nine pounds, and the other, the deep-sea lead, weighing from twenty-five to thirty pounds, and both are shaped like the frustrum of a cone or pyramid. The former is used in shallow waters, and the latter at a great distance from the shore, particularly on approaching the land after a sea voyage. Accordingly, the lines employed for this purpose are called the deep-sea-lead, and the hand-lead line. The hand-lead line, which is generally twenty fathoms in length, is marked at every two or three fathoms, so that the depth of water may be ascertained either in the day or night. At the depth of two and three fathoms, there are marks of black leather; at five fathoms, there is a white rag, at seven, a red rag; at ten, black leather; at thirteen, black leather; at fifteen, a white rag; and at seventeen, a red rag.

Sounding with the hand-lead, which is called heaving the lead by seamen, is generally performed by a man who stands in the main-chains to windward. Having the line all ready to run out without interruption, he holds it nearly at the distance of a fathom from the plummet, and having swung the latter backwards and forwards three or four times, in order to acquire the greater velocity, he swings it round his head, and thence as far forward as is necessary, so that, by the lead's sinking while the ship advances, the line may be almost perpendicular when it reaches the bottom. The person sounding then proclaims the depth of the water in a kind of song, resembling the cries of London hawkers. Thus, if the mark of five fathoms is close to the surface of the water, he calls, "By the mark five," and as there is no mark at four, six, eight, &c. he estimates those numbers, and calls, "By the dip four." If he judges it to be a quarter or an half more than any particular number, he calls, "And a quarter five—and a half four," &c. If he conceives the depth to be three quarters more than a particular number, he calls it a quarter less than the next: thus, at four fathoms and three quarters, he calls, "A quarter less five," &c.

The deep-sea-lead is marked with two knots at twenty fathoms, three at forty, four at fifty, and so on to the end. It is also marked with a single knot in the middle of each interval, as at twenty-five, thirty-five, forty-five fathoms, &c. To use this lead more effectually at sea, or in deep water on the sea coast, it is usual previously to bring-to the ship, in order to retard her course; the lead is then thrown as far as possible from the ship, on the line of her drift, so that as it sinks, the ship drives more perpendicularly over it. The pilot, feeling the lead strike the bottom readily, discovers the depth of the water by the mark on the line nearest its surface.

SOUP, a strong decoction of flesh or other substances. Portable or dry soup is a kind of cake formed by boiling the gela-

tinous parts of animal subsances till the watery parts are evaporated. This species of soup is chiefly used at sea, and has been found of great advantage. The following receipt will show how it is prepared: Of calves feet take four, leg of beef twelve pounds, knuckle of veal three pounds, and leg of mutton ten pounds. These are to be boiled in a sufficient quantity of water, and the scum taken off as usual; after which the soup is to be separated from the meat by straining and pressure. The meat is then to be boiled a second time in other water; and the two decoctions, being added together, must be left to cool, in order that the fat may be exactly separated. The soup must then be clarified with five or six whites of eggs, and a sufficient quantity of common salt added. The liquor is then strained through flannel, and evaporated on the water-bath to the consistence of a very thick paste; after which it is spread rather thin upon a smooth stone, then cut into cakes, and lastly dried in a stove till it becomes brittle: these cakes are kept in well-closed bottles. The same process may be used to make a portable soup of the flesh of poultry; and aromatic herbs may be used as a seasoning, if thought proper. These tablets, or cakes, may be kept four or five years: when intended to be used, the quantity of half an ounce is put into a large glass of boiling water, which is to be covered, and set upon hot ashes for a quarter of an hour, or until the whole is entirely dissolved. It forms an excellent soup, and requires no addition but a small quantity of salt.

SOUTHING *of the Moon*, the time at which the Moon passes the meridian of any particular place.

SOW, in zoology, the female of the hog-kind. See Sus.

Sow, in the iron-works, the name of the block or lump of metal they work at once in the iron furnace. The size of these sows of iron is very different, even from the same workmen, and the same furnace. These furnaces having sand stones for their hearths and sides up to the height of a yard, and the rest being made of brick, the hearth by the force of the fire is continually growing wider, so that if it at first contains as much metal as will make a sow of six or seven hundred weight, it will at last contain as much as will make a sow of two thousand weight.

SPACE, is defined by Mr. Locke, to be a simple idea, which we attain both by our sight and touch. The modes whereof are distance, capacity, extension, duration, &c. Space, considered barely in length between two bodies, is the same idea which we have of distance. If it be considered in length, breadth, and thickness, it is properly called capacity; when considered between the extremities of matter which fills the capacity of space, with something solid, tangible, and moveable, it is then called extension, so that extension is an idea belonging to a body, but space, it is plain, may be conceived without it. Each different distance is a different modification of space, and each idea of any different space is a simple mode of this idea: such are an inch, foot, yard, &c. which are the ideas of certain stated lengths, which men settle in their minds for the use, and by the custom of measuring. When these ideas are made familiar to men's thoughts, they can repeat them as often as they will, without joining to them the idea of body, and frame to themselves the ideas of feet, yards, or fathoms, beyond the utmost bounds of all bodies, and by adding these still one to another, enlarge their idea of space as much as they please. From this power of repeating any idea of distance without ever coming to an end, we come by the idea of immensity. Another modification of space is taken from the relation of the termination of the parts of extension, or circumscribed space, amongst themselves; and this is what we call figure. This the touch discovers in sensible bodies, whose extremities come within our reach; and the eye takes, both from bodies and colours, whose boundaries are within its view; where observing how the extremities terminate, either in straight lines, which meet at discernible angles; or in crooked ones, wherein no angles can be perceived; by considering these as they relate to one another in all parts of the extremities of any body or space, it has that idea we call figure, which affords to the mind infinite variety. Another mode belonging to this head is, that of place. There is another mode of space, the idea of which we get from the fleeting and perpetually perishing parts of succession, which we call duration. Space is usually divided into absolute and relative. Absolute space is that considered in its own nature, without regard to any thing external, which always remains the same, and is infinite and immoveable. Relative space, is that moveable dimension, or measure of the former, which our senses define

by its positions to bodies within it, and this is the vulgar use for immoveable space. Relative space, in magnitude and figure, is always the same with absolute; but it is not necessary it should be so numerically; as if you suppose a ship to be, indeed, in absolute rest, then the places of all things within her will be the same, absolutely and relatively, and nothing will change its place: but suppose the ship under sail, or in motion, and she will continually pass through new parts of absolute space; but all things on board, considered relatively in respect to the ship, may be, notwithstanding, in the same places, or have the same situation and position in regard to one another.

Space, in geometry, denotes the area of any figure, or that which fills the interval or distance between the lines that terminate it.

Space, in mechanics, the line a moveable body, considered as a point, is conceived to describe by its motion.

SPADIX, in botany, a term formerly applied to the receptacle of the palms: it is now used to express every flower stalk that is protruded out of a spatha or sheath.

SPAN, a measure taken from the space between the thumb's end and the tip of the little finger, when both are stretched out. The span is estimated at three hand's breadths, or nine inches.

Span, in naval affairs, a small line or cord, the middle of which is usually attached to a stay, whence the two ends branch outwards to the right and left, having either a block or thimble attached to their extremities.

SPAR, a name given to those earths which break easily into rhomboidal, cubical, or laminated fragments, with polished surfaces. As the term spar is thus applied to stones of different kinds, without any regard to the ingredients of which they are composed, some additional term must be used to express the constituent parts as well as the figure. The spars found in Britain and Ireland are of four different species: opaque, refracting, diaphanous, and stalactical. A species of spar has also been found in the East Indies, which, from its extreme hardness, approaching to that of a diamond, is called adamantine spar. It was discovered by Dr. Black, of Edinburgh, to be a distinct species. There are two varieties; one of them comes from China, and crystalizes in hexagonal prisms without pyramids, the length of the sides varying from six to twelve lines, their breadth being about nine, of a grey colour with different shades. Though the entire pieces are opaque, the thin laminæ are transparent, and when broken, its surfaces appear slightly striated. Its crystals are covered with a very fine and strongly adhering crust, composed of scales of silvery mica, mixed with particles of red felspar. Sometimes the surface has martial pyrites or yellow sulphuret of iron adhering to it. Its hardness is so great, that it not only cuts glass as easily as the diamond, but even scratches rock crystal and other very hard stones. Its specific gravity is to that of water as 2.7 to 1.0. Sometimes it contains crystalized grains of magnetic oxide of iron, which may be separated from the stone, when pulverised, by means of the loadstone. The other kind, found in Hindoostan, is of a whiter colour, and of a more laminated texture than the former. The grains of iron contained in it are likewise a smaller size than those of the former; they are not diffused through its substance, but only adhere to its surface. This spar is exceedingly difficult to analyze. M. Morveau appears to have ascertained that this stone is also found in France. A small bit of it was tried in the presence of Mr. Wedgewood, and he found that its specific gravity was superior to the spar of China, being no less than 4.18, and the true adamantine spar of China gave 3.82.

Although the word spar seems to include almost all the earthy crystalized minerals that are met with in metallic veins; yet mineralogists have generally agreed to apply the term to those minerals, whether earthy or metallic, which are crystalized, and have a visible foliated texture. Hence we have felspar-spar, fluor-spar, &c. Some of the spars have already been described in their alphabetical order; others we shall enumerate here.

Spar, *cube*, is of a milk-white colour, which passes sometimes into a greyish-white, and even into a reddish-white. It is massive; the lustre is shining, passing to splendent, and perfectly pearly. The fragments are cubical. Specific gravity is 2.9. It is found in salt rocks in the Archbishopric of Salzbourg.

Spar, *diamond*, is of a dark brown colour; it occurs massive, disseminated, in rolled pieces, and crystalized in six sided prisms and pyramids: internally its lustre is splendent, and generally pearly, approach-

ing in a slight degree to adamantine. Specific gravity nearly 4. Its constituent parts are, according to Klaproth,

Alumina	84.0
Silica	6.5
Oxide of Iron	7.5
	98.0
Loss	2
	100.0

It is found in China, and supposed to occur in granite. It is used in cutting and polishing hard minerals. It is reckoned to belong to the flint genus.

Spar, *fel*, or Feldspar, is a species of the clay genus, divided by Werner into four sub-species, *viz.* the compact and the common felspar, adularia and labrador stone.

Compact felspar is of a grey colour, passing to the white, blue, green, and red. It occurs massive, disseminated in rolled pieces, and in crystals; internally its lustre is sometimes glistening, sometimes glimmering. It is fusible, without addition, before the blow-pipe. It is found in Germany, and many parts of this country, particularly in Scotland, at the Pentland hills, and Salisbury craigs, near Edinburgh. It is one of the constituent parts of primitive, transition, and floetz green stone slate, and is also imbedded in crystals in antique porphyry.

The common felspar is one of the most abundant of fossils, and forms a constituent part of granite and gneiss; it occurs also in sienite, in greenstone, and in imbedded crystals in porphyry, basalt, and porphyry-slate. Its specific gravity is from 2.4 to 2.7. It melts before the blow-pipe, without addition, into a white glass. A specimen, analyzed by Kirwan, was found to consist of

Silica	67.0
Alumina	14.0
Barytes	11.0
Magnesia	8.0
	100.0

Adularia is of a greenish white: is found massive, in rolled pieces, and crystalized. Specific gravity from 2.5 to 2.6. It melts, without addition, before the blow-pipe into a whitish glass. It is found in veins and cavities, in gneiss and mica slate, and is accompanied with quartz, mica, common felspar, and tourmaline. It consists, according to the analysis of Vauquelin, of

Silica	64
Alumina	20
Lime	2
Potash	14
	100

It is found in the mountain of St. Gothard in Switzerland, and particularly in the summit named Adula, hence its name. See Labrador *stone*.

Spar, *fluor*. See Fluoric *acid*.

Spar, *heavy*. See Barytes. See also Rhomb *spar*, &c.

Spars, in ship building, large round pieces of timber, fit for making top-masts.

SPARGANIUM, in botany, *bur-reed*, a genus of the Monoecia Triandria class and order. Natural order of Calamariæ. Typhæ, Jussieu. Essential character: male and female; ament roundish; calyx three-leaved; corolla none: female, stigma bifid; drupe juiceless, one-seeded. There are three species.

SPARGEL *stone*, or Spargelstein; called also Asparagus *stone*, which see.

SPARRMANNIA, in botany, so named in memory of Anders, or Andrew Sparrman, a Swede, a genus of the Polyandria Monogynia class and order. Natural order of Columniferæ. Filiaceæ, Jussieu. Essential character: calyx four-leaved; corolla of four reflexed petals; nectary several, torulose; capsule angular, five-celled, echinate. There is only one species, *viz.* S. Africana, a native of the Cape of Good Hope.

SPARROW, in ornithology, a species of the fringilla. See Fringilla.

SPARTIUM, in botany, *broom*, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: calyx produced downwards; filaments adhering to the germ; stigma longitudinal, villose above. There are twenty-seven species. The S. scoparium, or common broom, is used for a variety of purposes. It has been of great benefit sometimes in dropsical complaints. The manner in which Dr. Cullen administered it was this: he ordered half an ounce of fresh broom tops to be boiled in a pound of water till one half of the water was evaporated. He then gave two table-spoonsfull of the decoction every hour till it operated both by stool and urine. By repeating these doses every day, or every second day, he says some

dropsies have been cured. Dr. Mead relates, that a dropsical patient, who had taken the usual remedies, and had been tapped three times without effect, was cured by taking half a pint of the decoction of queen-broom tops, with a spoonful of whole mustard seed, every morning and evening. "An infusion of the seeds drunk freely (says Mr. Withering) has been known to produce similar happy effects, but whoever expects these effects to follow in every dropsical case will be greatly deceived. I knew them succeed in one case that was truly deplorable, but out of a great number of cases in which the medicine had a fair trial, this proved a single instance."

The flower-buds are in some countries pickled, and eaten as capers; and the seeds have been used as a bad substitute for coffee. The branches are used for making besoms, and tanning leather. They are also used instead of thatch to cover houses. The old wood furnishes the cabinet maker with beautiful materials for veneering. The tender branches are in some places mixed with hops for brewing, and the macerated bark may be manufactured into cloth.

SPARUS, in natural history, a genus of fishes of the order Thoracici. Generic character: teeth strong, sometimes arranged in a single row, and sometimes in two rows or more, grinders generally convex, smooth, and thickly planted in the mouth like a species of pavement, lips doubled, gill covers unarmed, smooth, and scaly. There are forty species, but little is known of their habits and manners, and in some instances, Shaw observes, that they are confounded by naturalists with the genus Labrus. S. auratus, or gilt-headed sparus, is found in the European, American, and Indian seas, is about fifteen inches long, and was admired as a great delicacy by the ancients, by whom it was also consecrated to Venus.

SPATHA, in botany, a *sheath*, a species of calyx which bursts lengthways, and protrudes a stalk supporting one or more flowers, which commonly have no perianthium or proper flower cup. The spatha opens on one side, from bottom to top, and consists either of one piece, as in the narcissus, snow drop, and the greater number of spathaceous plants: of two, as in the marsh aloe; or of a number of scales laid over one another like tiles, as in the plantain-tree.

SPATHACEÆ, the name of the ninth order in Linnæus's Fragments of a Natural Method, consisting of plants, the flowers of which are protruded from a sheath: among these are the allium, onion, galanthus, snow-drop, and narcissus daffodil. The plants of this order are nearly allied in habit and structure to the liliaceous plants, from which they are distinguished by the spatha, or sheath, out of which their flowers are protruded.

SPATHELIA, in botany, a genus of the Pentandria Trigynia class and order. Natural order of Bicornes. Terebintaceæ, Jussieu. Essential character: calyx five-leaved, petals five, capsule three-cornered, three celled; seeds solitary. There is only one species, viz. S. simplex, rhus-leaved spathelia, a native of Jamaica.

SPATULA, an instrument used by surgeons and apothecaries.

SPAYING, an operation performed on the females of several kinds of animals, to prevent any further conception, and promote their fattening.

SPEAKER *of the House of Commons*, a member of the house elected by a majority of the votes thereof, to act as chairman or president in putting questions, reading briefs or bills, keeping order, reprimanding the refractory, adjourning the house, &c. The first thing done by the commons, upon the first meeting of a parliament, is to choose a Speaker, who is to be approved of by the king, and who, upon his admission, begs his Majesty that the commons, during their sitting, may have free access to his Majesty, freedom of speech in their own house, and security from arrests. The Speaker is not allowed to persuade or dissuade in passing a bill, but only to make a short and plain narrative; nor to vote unless the house be equally divided.

SPECIES, in logic, a relative term, expressing an idea which is comprised under some general one, called a genus. The idea of a species is formed, by adding a new idea to the genus: thus if the genus be a circumscribed space, and we suppose this circumscription to be by lines, we shall obtain the notion of that species of figures which are called plain figures; but if we conceive the circumscription to be by surfaces, we get an idea of the species of solid figures. This superadded idea is called the specific difference, not only as it serves to distinguish the species from the genus; but because being different in all the several subdivisions, we thereby also distinguish the species one from another. and as this superadded conception completes the notion of

the species, it is plain that the genus and specific difference are the proper and constituent parts of the species. If we trace the progress of the mind still further, and observe it advancing through the inferior species, we shall find its manner of proceeding to be always the same; since every lower species is formed, by superadding some new idea to the species next above: thus if animal be the genus, by superadding the notion of four limbs, we obtain the idea of quadrupeds; if to this we add further, the peculiar form and characters which distinguish mankind, we get the idea of the human species; and by adding the peculiarities which distinguish a particular person from all others, we form the notion of an individual, which is called the last species, or species specialissimum.

For the use of the genus, species, and specific difference in defining things. See DEFINITION.

SPECIES, in logic, is one of the five words called by Porphyry universals. See UNIVERSAL.

SPECIES, in rhetoric, is a particular thing, contained under a more universal one.

SPECIES, in commerce, are the several pieces of gold, silver, copper, &c. which having passed their full preparation and coinage are current in public.

SPECIES, in algebra, the characters or symbols made use of to represent quantities.

SPECIFIC, in philosophy, that which is peculiar to any thing, and distinguishes it from all others.

SPECIFIC, in medicine, a remedy whose virtue and effect is peculiarly adapted to some certain disease, is adequate thereto, and exerts its whole force immediately thereon.

SPECIFIC *gravity*, is that by which one body is heavier than another of the same dimension, and is always as the quantity of matter under that dimension. As to the method of finding the specific gravities of bodies. See HYDROSTATICS.

SPECTACLE. See VISION.

SPECTRA, *ocular*. See RETENTION.

SPECTRUM, in optics. When a ray of light is admitted through a small hole, and received on a white surface, it forms a luminous spot. If a dense, transparent body be interposed, the light will be refracted, in proportion to the density of the medium; but if a triangular glass prism be interposed, the light is not merely refracted, but it is divided into seven different rays. The ray of light no longer forms a luminous spot, but has assumed an oblong shape, terminating in semicircular arches, and exhibiting seven different colours. This image is called the spectrum, and, from being produced by the prism, the prismatic spectrum. These different coloured rays appearing in different places of the spectrum, show that their refractive power is different. Those which are nearest the middle are the least refracted, and those which are the most distant, the greatest. The order of the seven rays of the spectrum is the following: red, orange, yellow, green, blue, indigo, violet. The red, which is at one end of the spectrum, is the least, and the violet, which is at the other end, is the most refracted. Sir Isaac Newton found, if the whole spectrum was divided into 360 parts, the number of the parts occupied by each of the colours to be the following:

Red	45 parts.
Orange	27
Yellow	48
Green	60
Blue	60
Indigo	40
Violet	80

These different coloured rays are not subject to further division. No change is effected upon any of them by being further refracted or reflected; and, as they differ in refrangibility, so also do they differ in the power of inflection and reflection. The violet rays are found to be the most reflexible and inflexible, and the red the least.

SPECULATIVE, something relating to the theory of some art or science, in contradistinction to practical.

SPECULUM, a *looking glass*, or *mirror*, capable of reflecting the rays of the sun, &c. See MIRROR and TELESCOPE.

SPECULUM, in surgery, an instrument for dilating a wound, or the like, in order to examine it attentively.

SPERGULA, in botany, *spurrey*, a genus of the Decandria Pentagynia class and order. Natural order of Caryophyllei. Essential character: calyx five-leaved; petals five, entire; capsule ovate, one-celled, five-valved. There are seven species. The S. arvensis, corn-spurrey, has linear-furrowed leaves, from eight to twenty in a whorl. The flowers are small, white, and terminal. It is frequent in corn-fields. In Holland it is cultivated as food for cattle, and has the advantage of growing on the very poorest soils, but does not afford a great deal of food. Poultry are fond of the seeds; and the inhabitants of Finland and Norway

make bread of them when their crops of corn fail.

SPERMACETI is found in the head of the Physeter macrocephalus, a species of whale; it is obtained in an unctuous mass, from which oil is obtained by expression. Spermaceti is also found in other cetaceous fishes, and in other parts of the body, mixed with the oil. It is a fine white substance of a crystalized texture, very brittle, and has little taste or smell. It crystalizes in the form of shining silvery plates. It melts at the temperature of 112°. With a greater heat it may be distilled without change; but, by repeated distillation, it is decomposed, and partly converted into a brown acid liquid. It is soluble in boiling alcohol, but it separates when the solution cools. It is also soluble in ether, both cold and hot. In the hot solution it concretes on cooling into a solid mass. Spermaceti is scarcely at all soluble in the acids. It combines readily with the pure alkalies, with sulphur, and with the fixed oils. By exposure to the air it becomes rancid. The uses of spermaceti are well known, and particularly in the manufacture of candles. Spermaceti differs chiefly from oil, by its solubility in alcohol and ether. According to Dr. Bostock, it requires 150 times its weight of alcohol, boiling hot, to dissolve it, and, as the fluid cools, the spermaceti precipitates.

Spermaceti candles are of modern manufacture: they are made smooth, with a fine gloss, free from rings and scars, superior to the finest wax-candles in colour and lustre; and, when genuine, leave no spot or stain on the finest silk, cloth, or linen. A method has been lately proposed by Dr. Smith Gibbes, of Magdalen College, Oxford, to convert animal muscle into a substance much resembling spermaceti. The process is remarkably simple: nothing more is necessary than to take a dead carcase and expose it to a stream of running water: it will in a short time be changed to a mass of fatty matter. To remove the offensive smell, a quantity of nitrous acid may then be poured upon it, which, uniting with the fetid matter, the fat is separated in a pure state. This acid indeed turns it yellow, but it may be rendered white and pure by the action of the oxygenated muriatic acid. Dr. Gibbes brought about the same change in a much shorter time. He took three lean pieces of mutton, and poured on them the three mineral acids, and he perceived, that at the end of three days each was much altered; that in the nitrous acid was much softened, and, on separating the acid from it, he found it to be exactly the same with that which he had before got from the water; that in the muriatic acid was not in that time so much altered; the vitriolic acid had turned the other black. See the article ADIPOCIRE.

SPERMACOCE, in botany, *button weed*, a genus of the Tetrandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: corolla one-petalled, funnel-shaped; seeds two, two-toothed. There are twenty species.

SPHÆRANTHUS, in botany, a genus of the Syngenesia Polygamia Segregata class and order. Natural order of Compositæ Capitatæ. Cinarocephalæ, Jussieu. Essential character: calyx eight-flowered; corolla tubular, hermaphrodite, and indistinct: female, receptacle scaly; down none. There are four species.

SPHÆRIA, in botany, a genus of the Cryptogamia Fungi. Generic character: fructifications mostly spherical, opening at the top, whilst young filled with jelly, when old with a blackish powder. They grow on the bark or wood of other plants; capsules often immersed, so that their orifices only are visible: most of the species are without a stem.

SPHÆROCARPUS, in botany, a genus of the Cryptogamia Hepaticæ. Generic character: calyx ventricose, undivided; seeds numerous, collected into a globe.

SPHAGNUM, in botany, a genus of the Cryptogamia Musci. Generic character: male, flower club-shaped; anthers flat; capsule on the same plant, sessile, covered with a lid, without any entire veil; mouth smooth.

SPHERE, is a solid contained under one uniform round surface, such as would be formed by the revolution of a circle about a diameter thereof, as an axis. Thus the circle A E B D (see Plate XIV. Miscel. fig. 2,) revolving about the diameter A B, will generate a sphere, whose surface will be formed by the circumference of the circle.

Definitions. 1. The centre and axis of a sphere, are the same as the centre and diameter of the generating circle: and as a circle has an indefinite number of diameters, so a sphere may be considered as having also an indefinite number of diameters, round any one of which the sphere may be conceived to be generated. 2. Circles of the sphere are those circles describ-

ed on its surface, by the motions of the extremities of the chords E D, F G, I H, &c. at right angles to A B; the diameters of which circles are equal to those chords. 3. The poles of a circle on the sphere, are those points on its surface, equally distant from the circumference of that circle: thus A and B are the poles of the circles described on the sphere by the ends of the chords E D, F G, I H, &c. 4. A great circle of the sphere is one equally distant from both its poles, as that described by the extremities of the diameter E D, which is equally distant from both its poles A and B. 5. Lesser circles of the sphere are those which are unequally distant from both their poles, as those described by the extremities of the chords F G, H I, &c. because unequally distant from their poles A and B. See CIRCLE.

Axioms. 1. The diameter of every great circle passes through the centre of the sphere: but the diameters of all lesser circles do not pass through the same centre: hence also the centre of the sphere is the common centre of all the great circles. 2. Every section of a sphere by a plane, is a circle. 3. A sphere is divided into two equal parts, or hemispheres, by the plane of every great circle; and into two unequal parts, called segments, by the plane of every lesser circle. 4. The pole of every great circle is 90° distant from it on the surface of the sphere; and no two great circles can have a common pole. 5. The poles of a great circle are the two extremities of that diameter of the sphere, which is perpendicular to the plane of that circle. 6. A plane passing through three points on the surface of the sphere, equally distant from any of the poles of a great circle will be parallel to the plane of that great circle. 7. The shortest distance between two points, on the surface of a sphere, is the arch of a great circle passing through these points. 8. If one great circle meets another, the angles on either side are supplements to each other; and every spherical angle is less than 180°. 9. If two circles intersect each other, the opposite angles are equal. 10. All circles on the sphere, having the same pole, are cut into similar arches, by great circles passing through that pole.

SPHERE, *properties of the.* 1. All spheres are to one another as the cubes of their diameters. 2. The surface of a sphere is equal to four times the area of one of its great circles, as is demonstrated by Archimedes in his book of the Sphere and Cylinder, lib. i. prop. 37. hence, to find the superfices of any sphere, we have this easy rule; let the area of a great circle be multiplied by 4, and the product will be the superficies: or, according to Euclid, lib. vi. prop. 20. and lib. xii. prop. 2. the area of a given sphere, C E B D (fig. 3) is equal to that of a circle, whose radius is equal to the diameter of the sphere B C. Therefore, having measured the circle described with the radius B C, this will give the surface of the sphere. 3. The solidity of a sphere is equal to the surface multiplied into one third of the radius: or, a sphere is equal to two thirds of its circumscribing cylinder, having its base equal to a great circle of the sphere. Let A B E C (fig. 4 and 5), be the quadrant of a circle, and A B D C the circumscribed square, equal twice the triangle A D C: by the revolution of the figure about the right line A C, as an axis, a hemisphere will be generated by the quadrant, a cylinder of the same base and height of the square, and a cone by the triangle: let these three be cut any how by the plane H F, parallel to the base A B; and the section of the cylinder will be a circle, whose radius is F H; in the hemisphere, a circle whose radius is F E; and in the cone, a circle of the radius F G. But $EA^2 (= HF^2) = EF^2 + FA^2$: but $AF^2 = FG^2$, because $AC = CD$; and therefore $HF^2 = EF^2 + FG^2$; or the circle of the radius H F, is equal to a circle of the radius E F, together with a circle of the radius G F: and since this is true every where, all the circles together described by the respective radii H F, that is the cylinder, are equal to all the circles described by the respective radii E F and F G, that is, to the hemisphere and cone taken together. But by Euclid. lib. xii. prop. 10. the cone generated by the triangle D A C, is one third part of the cylinder, generated by the square B C, whence it follows, that the hemisphere generated by the rotation of the quadrant A B E C, is equal to the remaining two thirds of the cylinder, and that the whole sphere is two thirds of the cylinder circumscribed about it. Hence it follows, that a sphere is equal to a cone whose height is equal to the semi-diameter of the sphere, and its base equal to the superficies of the sphere, or to the area of four great circles of the sphere, or to that of a circle, whose radius is equal to the diameter of the sphere.

SPHERE, in astronomy, that concave orb,

or expanse, which invests our globe, and in which the heavenly bodies appear to be fixed, and at an equal distance from the eye. The better to determine the places of the heavenly bodies in the sphere, several circles are supposed to be described on the surface thereof, hence called the circles of the sphere: of these, some are called great circles, as the equinoctial, ecliptic, meridian, &c. and others, small circles, as the tropics, parallels, &c. See each under its proper article.

SPHERICS, is that part of geometry which treats of the position and mensuration of arches of circles, described on the surface of a sphere. See SPHERE.

SPHEROID, in geometry, a solid, approaching to the figure of a sphere.

The spheroid is generated by the entire revolution of a semi-ellipsis about its axis. Thus, if the semi-ellipsis A H F B (Plate XIV. Miscel. fig. 6,) be supposed to revolve round its transverse axis A B, it will generate the oblong spheroid A H F B C. Now as all circles are as the squares described upon their radii; that is, the circle of the radius E H, is to the circle of the radius E G, as CF^2 to CD^2, because E H : E G : : C F : C D, and since it is so every where, all the circles described with the respective radii E H, (that is, the spheroid made by the rotation of the semi-ellipsis A F B about the axis A B) will be to all the circles described by the respective radii EG, (that is, the sphere described by the rotation of the semi-circle A D B on the axis A B) as FC^2 to CD^2; that is, as the spheroid is to the sphere on the same axis, so is the other axis of the generating ellipsis to the square of the diameter or axis of the sphere: and this holds whether the spheroid be formed by a revolution around the greater or lesser axis.

Hence it appears, that the half of the spheroid, formed by the rotation of the space A H F C, around the axis A C, is double of the cone generated by the triangle A F C, about the same axis. Hence, also, is evident the measure of the segments of the spheroid, cut by planes perpendicular to the axis: for the segment of the spheroid, made by the rotation of the space A N H E round the axis A E, is to the segment of the sphere, having the same axis A C, and made by the rotation of the segment of the circle A M G E, as CF^2 to CD^2. But the measure of this solid may be found with less trouble by this analogy; viz. as B E : A C + E B : : so is the cone generated by the rotation of the triangle A H E round the axis A E: to the segment of the sphere made by the rotation of the space A N H E round the same axis A E, as is demonstrated by Archimedes of conoids and spheroids, prop. 34. This agrees as well to the oblate as to the oblong spheroid. A spheroid is also equal to two thirds of its circumscribing cylinder. As to the superficies of a spheroid, M. Huygens gives the two following constructions in his Horolog. Oscill. For describing a circle equal to the superficies of an oblong and prolate spheroid: 1. Let an oblong spheroid be generated by the rotation of the ellipsis A D B E, (fig. 7) about its transverse axis A B, and let D E be its conjugate; make D F equal to C B, or let F be one of the foci, and draw B G parallel to F D, and about the point G, with the radius B G, describe an arch, B H A, of a circle; then between the semi-conjugate C D, and a right line equal to D E + the arch A H B, find a mean proportional, and that will be the radius of a circle equal to the superficies of the oblong spheroid. 2. Let a prolate spheroid be generated by the rotation of the ellipsis A D B E (fig. 8) about its conjugate axis A B. Let F be one of the foci, and bisect C F in G, and let A G B be the curve of the common parabola whose base is the conjugate diameter A B, and axis C G. Then if between the transverse axis D E, and a right line equal to the curve A G B of the parabola, a mean proportional be taken, the same will be the radius of a circle equal to the surface of that prolate spheroid.

SPHEX, in natural history, a genus of insects of the order Hymenoptera. Mouth with an entire jaw, the maudibles horny, incurved, toothed; lip horny, membranaceous at the tip; four feelers; antennæ with about ten articulations; wings, in each sex, plane, incumbent, and not folded; sting pungent and concealed within the abdomen. There are about one hundred and fifty species, divided into sections. A. antennæ, setaceous; and entire lip and no tongue. B. antennæ filiform; lip emarginate, with a bristle on each side; tongue inflected, trifid. The insects of this genus are the most savage and rapacious of this class of beings: they attack whatever comes in their way, and by means of their poisonous sting overcome and devour others far beyond their own size. Those belonging to section B are found chiefly on umbellate plants; the larva is without feet, soft, and

inhabits the body of some other insect, on whose juices it exists: the pupa has rudiments of wings.

S. maculata, is found in England. Thorax spotted; first segment of the abdomen with a white dot on each side; second, edged with white. See Plate IV. Entomology, fig. 6.

S. figulus, an inhabitant of Upsal, is smooth and black; segments of the abdomen at the edges and lip lucid. It is found in holes of wooden partitions, abandoned by other insects; these it cleanses by gnawing round them, and placing a piece of moist clay at the bottom sticks a spider upon it; in the body of this spider it deposits its eggs, and then closes up the entrance with clay, and leaves it to be devoured by the larva.

S. spirifex, is black; thorax hairy, immaculate; petiole of one joint, yellow, as long as the abdomen. This insect is found in Egypt, and in several parts of Europe, in cylindrical cavities, wrought within like a honey-comb, on the sides of cliffs, and in the mud walls of cottages.

S. figulus, is one of the species mentioned by Dr. Shaw. This insect having found some convenient cavity, seizes a spider, and having killed it, deposits it at the bottom; then laying her egg in it, she closes up the orifice of the cavity with clay; the larva, which resembles the maggot of a bee, having devoured the spider, spins itself up in a dusky silken web, and changes into a chrysalis, out of which, within a certain number of days, proceeds the complete insect. The female of this species prepares several separate holes, or nests, in each of which she places a dead insect and an egg; each cell costing her the labour of about two days.

SPHINCTER, in anatomy, a term applied to a kind of circular muscles, or muscles in form of rings, which serve to close and draw up several orifices of the body, and prevent the excretion of the contents: thus the sphincter of the anus closes the extremity of the intestinum rectum.

SPHINX, in natural history, *hawk-moth*, a genus of insects of the order Lepidoptera. Antennæ somewhat prismatic, tapering at each end; tongue mostly exserted; two feelers, reflected; wings deflected. There are about two hundred species; these fly abroad in the morning and evening, are very slow on the wing, and often make a humming kind of noise; they extract the nectary of flowers with the tongue; the larva has sixteen feet, and is pretty active. The name of the sphinx is applied to the genus on account of the posture assumed by the larvæ of several of the larger species, which are said to be seen in an attitude much resembling that of the Egyptian sphinx. This numerous genus is divided into sections: A. antennæ scaly; feelers hairy; tongue spiral. B. antennæ cylindrical; tongue exserted, truncate; wings entire. C. antennæ thicker in the middle; tongue exserted. The largest, and perhaps the most beautiful of the European species, is S. atropos; of this, the upper wings are of a fine dark grey, with a few slight varigations, of dull orange and white; the body is orange coloured, with the sides marked with black bars, while along the top of the back, from the thorax to the tail, runs a broad blue-grey stripe; on the top of the thorax is a very large patch, of a most singular appearance, exactly resembling the usual figure of a skull. When in the least disturbed, or irritated, this insect emits a sound like the squeaking of a mouse or a bat. In many parts of Europe it is held much in dread by the vulgar, and regarded as the harbinger of misfortune. The caterpillar, from which this curious sphinx proceeds, is in the highest degree beautiful, and surpasses in size every other European insect of the kind, being sometimes five inches in length: its colour is a bright yellow, the sides marked by a row of seven most elegant broad stripes, of a mixed violet and sky-blue colour; on the last joint of the body is a horn, or process, hanging over the joint in the manner of a tail, having a rough or muricated surface, and a yellow colour. This caterpillar is principally found on the potatoe and the jasmine; it usually changes into a chrysalis in the month of September, retiring for that purpose pretty deep under the surface of the earth; the complete insect emerging in the following summer. This species is generally considered as a very rare insect; and as the caterpillar feeds chiefly by night, concealing itself during the day, it is not often seen. See Plate IV. Entomology, fig. 7.

S. ligustri, or privet hawk-moth, is a large insect, measuring nearly four inches and a half from wing's end to wing's end: the upper wings of a brown colour, most elegantly varied or shaded with deeper and lighter streaks and patches; the under wings and body are of a fine rose colour, barred with transverse black stripes. The caterpillar, which is very large, is smooth, and of a fine green, with seven oblique purple and

white stripes along each side, at the extremity of the body, or top of the last joint, is a horn or process pointing backwards. This beautiful caterpillar is often found in the months of July and August feeding on the privet, the lilac, the poplar, and some other trees, and generally changes to a chrysalis in August or September, retiring for that purpose to a considerable depth beneath the surface of the ground, and, after casting its skin, continuing during the whole winter in a dormant state, the sphinx emerging from it in the succeeding June.

S. ocellata, is perhaps still more beautiful it is rather a smaller insect than the preceding, and has the upper wings and body brown, the former finely clouded with different shades, while the lower wings are of a bright rose-colour, each marked with a large ocellated black spot, with a blue interior circle and a black centre. This insect proceeds from a green caterpillar, of a rough or shagreen like surface, marked on each side by seven oblique yellowish-white streaks, and furnished, like the preceding, with a horn at the tail. It is principally found on the willow; retires under ground, in order to undergo its change into the chrysalis state, in the month of August or September, and in the following June appears the complete insect.

SPICA, in botany, a term applied to a particular mode of flowering, in which the flowers are ranged alternately upon both sides of a simple common flower stalk. The flowers in the spica are seated immediately upon the stalk, without any partial footstalk, in which it differs from a racemus, or cluster. A spica is said to be single rowed when the flowers are all turned towards one side; and to be double rowed when they look to both sides, or stand two ways.

SPIDER. See Aranea.

SPIELMANNIA, in botany, so named in honour of James Reinbold Spielmann, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Vitices, Jussieu. Essential character: calyx five-cleft; corolla bearded at the throat, with a five-cleft almost equal border, drupe with a two-celled, two seeded nut. There is only one species, viz. S. Africana, silex leaved Spielmannia, or lantana, a native of the Cape of Good Hope.

SPIGELIA, in botany, so named in memory of Adrian Spigelius, a genus of the Pentandria Monogynia class and order. Natural order of Stellatæ. Gentianæ, Jussieu. Essential character: corolla funnel-shaped, capsule twin, two-celled, many-seeded. There are two species, viz. S. anthelmia, annual worm grass, and S. marilandica, perennial worm grass.

SPIKING *up the ordnance*, a sea phrase, used for fastening a quoin with spikes to the deck close to the breech of the carriages of great guns, that they may keep close and firm to the ship's sides, and not get loose when the ship rolls, and by that means endanger the breaking out of a butt head of a plank.

SPILANTHUS, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: calyx almost equal, down two-toothed; receptacle conical, chaffy. There are nine species. This genus is made up chiefly of those species of bidens and verbesina which do not properly belong to those genera, they are natives of the East and West Indies.

SPINA, in botany, a *thorn*, a species of offensive weapon, protruded from the wood of the plant, and which is therefore of a stronger and harder nature than prickles, which are detached portions of the bark. Thorns, which are an expansion of the ligneous body, are compared to the horns of animals, which adhere to the bones of the skull, and are protruded from them.

SPINACIA, in botany, *spinach*, a genus of the Dioecia Pentandria class and order. Natural order of Holoraceæ. Atriplices, Jussieu. Essential character: male, calyx five-parted; corolla none: female, calyx four-cleft, corolla none, styles four, seed one, within the hardened calyx. There are two species, viz. S. oleracea, garden spinach, and S. fera, wild spinach. There are also two varieties.

SPINDLE, in the sea language, is the smallest part of the ship's capstan, which is between the two decks. The spindle of the jeer capstan has whelps to heave the viol. The axis of the wheel of a watch or clock, is also called the spindle. Among miners, the spindle is a piece of wood fastened into either stow blade.

SPINELLE, in mineralogy, a species of the flint genus: its principal colour is red, from which it passes on the one side into blue, and even into green, on the other into yellow and brown. Its colours are mostly deep, and they have always a shade of black. Sometimes it is enveloped in an opaline crust, sometimes it exhibits an opalescent iridescence. It occurs in grains, which,

from their aspect, show that they have been rolled, and also crystallized. Its specific gravity is from 3.5 to 3.7. It is unalterable before the blow-pipe without addition; but is fusible with borax: it consists, according to Klaproth,

Alumina	74.5
Silica	15.5
Magnesia	8.25
Oxide of iron	1.50
Lime	75
	100.5

Vauquelin gives a somewhat different analysis. It is found in the kingdom of Pegu, and in the island of Ceylon, accompanied with zircon, hyacinth, tourmaline, and ceylanite. It is employed as a precious stone, and is of considerable value; but it is not so highly esteemed as the oriental ruby: from this it is distinguished by being harder, and of a greater specific gravity.

SPINET, or SPINNET, a musical instrument ranked in the second or third place among harmonious instruments. See MUSICAL *Instruments*.

SPINIFEX, in botany, a genus of the Polygamia Dioecia class and order. Natural order of Gramina, Gramineæ, or Grasses. Essential character: hermaphrodite, calyx glume two-valved, two-flowered; valves parallel to the rachis; corolla two-valved, awnless; stamens three; styles two: male, calyx common with the hermaphrodite; corolla and stamens similar. There is only one species; *viz.* S. squarrosus, a native of the East Indies, China, and Cochinchina, on sandy coasts.

SPINNING, the act of reducing silk, flax, hemp, hair, wool, or other matter, into thread. Spinning is either performed on the wheel, or with a distaff and spindle, or with other machines proper for the several kinds of working. Hemp, flax, nettle-thread, and other like vegetable matters, are to be wetted in spinning: silks, wools, &c. are spun dry, at least they do not stand in need of water: there is, however, a way of spinning or reeling silk as it comes off the cases or balls, where hot, or even boiling, water is to be used. The vast variety and importance of these branches of our manufactures, which are produced from cotton, wool, and flax, spun into yarn, together with the cheapness of provisions, and the low price of labour, in many foreign countries, which are the rivals of our trade, have occasioned many attempts at home to render spinning more easy, cheap, and expeditious. Mr. Arkwright has carried the invention to a high degree of perfection. He not only contrived methods for spinning cotton, but obtained a patent for making cotton, flax, and wool, into yarn. See MANUFACTURE *of Cotton.*

SPINTHERE, in mineralogy, one of the earthy fossils, of a greenish colour: it occurs crystallized, in irregular, double, four-sided pyramids, which are obliquely truncated. The crystals are small, and the fracture foliated. It melts very easily before the blow-pipe.

SPIO, in natural history, a genus of the Vermes Mollusca class and order: body projecting from a tube, jointed, and furnished with dorsal fibres; peduncles, or feet, rough with bristles, and placed towards the back; feelers two, long, simple; two eyes, oblong. There are two species; *viz.* S. seticornis: feelers thin and striate: is found in the ocean, principally where there is a clayey bottom: it is about three inches long: the tube is composed of agglutinated particles of earth, thin, erect, and thrice as long as the body; from this the animal projects its capillary white feelers in search of food, which consists of small marine worms: body whitish, with a tinge of green, and a red line down the middle of the back; the hind part sea-green; the fore part blackish grey, with transverse white striæ: head pale. The other species is S. filicornis: feelers thick and annulate: it inhabits the seas about Greenland; it is about an inch long, and from its tube projects its feelers in search of Planariæ, and other small marine worms.

SPIRÆA, in botany, a genus of the Icosandria Pentagynia class and order. Natural order of Pomaceæ. Rosaceæ, Jussieu. Essential character: calyx five-cleft; petals five; capsule many-seeded. There are twenty-two species.

SPIRAL, in geometry, a curve line of the circular kind, which, in its progress, recedes from its centre.

A spiral, according to Archimedes, its inventor, is thus generated: if a right line, as A B, (Plate Miscel. XIV. fig. 9) having one end fixed at B, be equally moved round, so as with the other end A to describe the periphery of a circle; and, at the same time, a point be conceived to move forward equally from B towards A, in the right line B A, so as that the point describes that line, while the line generates the circle: then will the point, with its two motions,

describe the curve line B 1, 2, 3, 4, 5, &c. which is called the helix or spiral line; and the plane space contained between the spiral line and the right line B A is called the spiral space.

If also you conceive the point B to move twice as slow as the line A B, so as that it shall get but half way along the line B A, when that line shall have formed the circle; and if then you imagine a new revolution to be made of the line carrying the point, so that they shall end their motion at last together, there will be formed a double spiral line, and the two spiral spaces, as you see in the figure. From the genesis of this curve, the following corollaries may be easily drawn. 1. The lines B 12, B 11, B 10, &c. making equal angles with the first and second spiral (as also B 12, B 10, B 8, &c.) are in arithmetical proportion. 2. The lines B 7, B 10, &c. drawn any how to the first spiral, are to one another as the arches of the circle intercepted between B A and those lines. 3. Any lines drawn from B to the second spiral, as B 18, B 22, &c. are to each other as the aforesaid arches, together with the whole periphery added on both sides. 4. The first spiral space is to the first circle as one to 3. And, 5, The first spiral line is equal to half the periphery of the first circle; for the radii of the sectors, and consequently the arches, are in a simple arithmetical progression, while the periphery of the circle contains as many arches equal to the greatest; wherefore the periphery to all those arches is to the spiral lines as 2 to 1.

Spiral, in architecture and sculpture, implies a curve that ascends, winding about a cone or spire, so as all the points thereof continually approach the axis. It is distinguished from the helix, by its winding around a cone, whereas the helix winds in the same manner around a cylinder.

Spirals, *proportional*, are such spiral lines as the rhumb lines on the terrestrial globe, which, because they make equal angles with every meridian, must also make equal angles with the meridians in the stereographic projection on the plane of the equator; and therefore will be, as Dr. Halley observes, proportional spirals about the polar point.

SPIRE, in architecture, was used by the ancients for the base of a column, and sometimes for the astragal, or tore. But, among the moderns, it denotes a steeple that continually diminishes as it ascends, whether conically or pyramidally.

SPLACHNUM, in botany, a genus of the Cryptogamia Musci class and order. Generic character: capsule cylindrical; veil and receptacle very large; fringe with eight teeth. Male, a bud on a different plant; circular, terminating.

SPLEEN. See Anatomy.

SPLENTS, or Splints, in surgery, pieces of wood, used in binding up broken limbs.

SPLICING, in the sea language, is the untwisting the ends of two cables or ropes, and working the several strands into one another by a fidd, so that they become as strong as if they were but one rope.

SPLINTER, a small shiver of wood, or the like. The splinters of fractured bones, if loose, are to be carefully removed, otherwise replaced.

SPODUMENE, in mineralogy, one of the earthy fossils, of a greenish-white colour, passing into apple-green. It occurs in small masses, is shining, and of a pearly lustre. Specific gravity about 3.2. It splits before the blow pipe into smallish yellowish folia, and at length melts into a greyish-white transparent glass. It is found in the mines of Upton, in Sweden, accompanied with quartz and black mica.

SPONDEE, *spondæus*, in ancient poetry, a foot consisting of two long syllables, as *omnes*.

Some give the appellation spondaic to verses composed wholly of spondees, or at least that end with two spondees; as,

Constitit, atque oculus Phrygia agmina circumspexit.

SPONDIAS, in botany, *hog-plum*, a genus of the Decandria Pentagynia class and order. Natural order of Terebintaceæ, Jussieu. Essential character: calyx five-toothed; corolla five-petalled; drupe with a five-celled nut. There are four species.

SPONDYLUS, in natural history, a genus of the Vermes Testacea class and order: animal a tethys: shell hard, solid, with unequal valves; one of the valves convex, the other rather flat: hinge with two recurved teeth, separated by a small hollow. There are four species: the shell of the S. gædaropus is slightly eared, and spinous: it inhabits the Mediterranean, Indian, and other seas, and is found in almost infinite varieties as to size, thickness, and colours; sometimes entirely purple, orange, white, or bloom colour; sometimes marked with various streaks, spots, dots, or bands.

SPONGIA, in natural history, *sponge*, a genus of the Vermes Zoophyta class and

order: animal fixed, torpid, of various forms, composed either of reticulate fibres, or masses of small spines, interwoven together, and clothed with gelatinous flesh, full of small mouths on its surface, by which it absorbs and rejects water. Between fifty and sixty species have been enumerated. S. officinalis is irregularly formed, porous, tough, lobed, and woolly: It is found in the Archipelago, Mediterranean, and Indian seas, adhering to rocks by a broad base: it is often found inclosing small stones, shells, and particles of sand: variety of marine animals pierce and gnaw it into irregular winding cavities, which appear on the outside by large holes higher than the rest: its colour varies from a pale to a deep yellow: the internal part, when cut perpendicular, consists of small tubes, composed of reticulate fibres, and ending on the outside in an infinite number of small circular holes, which are the bibulous mouths of the animal, each of which is surrounded by a few erect pointed fibres. This is the common sponge of the shops.

S. ventilabrum, is fan-shaped, regular, soft, with reticulate woody veins, covered with pores like a honeycomb. This species inhabits the Norway and American seas: is about six inches high, and five broad: exactly resembles a small Gorgonia flabellum in its shape and ramifications, except that the pores are angular, and the substance is spongy.

S. cristata, or cock's-comb sponge, is flat, erect, and soft, growing in the shape of cock's-combs, with rows of little holes along the tops, which project a little. It abounds on the rocks to the eastward of Hastings, in Sussex, where it may be seen at low-water. It is commonly about three inches long, and two inches high, and of a pale yellowish colour. When put into a glass vessel of sea water, it has been observed to suck in and squirt out the water through little mouths along the tops, giving evident signs of life.

S. tomentosa, or urens, stinging sponge, or crumb of bread sponge, is of many forms, full of pores, very brittle and soft, and interwoven with very minute spines. It is full of small protuberances, with a hole in each, by which it sucks in and throws out the water. It is very common on the British coast; and is frequently seen surrounding fucuses. It is found also on the shores of North America, Africa, and in the East Indies. When newly taken out of the sea, it is of a bright orange colour, and full of gelatinous flesh; but when dry, it becomes whitish, and when broken has the appearance of crumbs of bread. If rubbed on the hand, it will raise blisters; and if dried in an oven, its power of stinging is much increased, especially that variety of it which is found on the sea coast of North America.

S. fluviatilis, river sponge, is green, erect, brittle, and irregularly disposed in numerous branches. It abounds in many parts of Europe, in the fresh rivers of Russia and England, but particularly in the river Thames. It scarcely exhibits any symptoms of life; is of a fishy smell: its pores, or mouths, are sometimes filled with green gelatinous globules.

So early as the days of Aristotle sponges were supposed to possess animal life; the persons employed in collecting them having observed them shrink when torn from the rocks, thus exhibiting symptoms of sensation. The same opinion prevailed in the time of Pliny. But no attention was paid to this subject, till Count Marsigli examined them, and declared them vegetables. Dr. Peysonell, in a paper which he sent to the Royal Society in the year 1752, and in a second in 1757, affirmed they were not vegetables, but the production of animals; and has accordingly described the animals, and the process which they performed in making the sponges. Mr. Ellis, in the year 1762, was at great pains to discover these animals. For this purpose he dissected the spongia urens, and was surprised to find a great number of small worms of the genus nereis, or sea scolopendra, which had pierced their way through the soft substance of the sponge in quest of a safe retreat. That this was really the case, he was fully assured of, by inspecting a number of specimens of the same sort of sponge, just fresh from the sea. He put them into a glass filled with sea water; and then, instead of seeing any of the little animals which Dr. Peysonell described, he observed the papillæ, or small holes, with which the papillæ are surounded, contract and dilate themselves. He examined another variety of the same species of sponge, and plainly perceived the small tubes inspire and expire the water. He therefore concluded, that the sponge is an animal, and that the ends, or openings, of the branched tubes, are the mouths by which it receives its nourishment, and discharges its excrements.

SPOON-*bill*. See Platea.

SPOONING, in the sea language, is said of a ship, which, being under sail in a storm at sea, is unable to bear it, and consequently forced to put right before the wind.

SPORTING. Although we have not omitted to notice what generally appertains to the winged, finny, or quadruped parts of nature, it appeared to us better to collect the whole of the matter relating to sporting in general, under one head; thereby to preclude the necessity for reverting to other volumes for such information as might be sought. The reader will, however, remark, that we have, under the article ANGLING, furnished an ample detail of that diversion: therefore we shall proceed to the discussion of what relates to FOWLING. The first item presenting itself to our consideration is the gun; which ought always to be suited to the occasion. For ordinary field excursions, that is to say when questing for pheasants, or partridges, the piece ought to be conveniently light, and of rather a small bore; the barrel from two feet four to two feet six, or perhaps eight, inches in length. Chambered guns undoubtedly strike hardest, and in most instances will be found to scatter least. Hence a good marksman will prefer such; but taking care to allow full thirty yards distance to the bird, unless in cases of emergency, before the trigger is drawn. When this precaution is neglected, the chance of missing is greater; while, on the other hand, such birds as may be hit, are absolutely spoiled by the column of shot which brings them down. The gun requisite for cocking, that is for wood-cock shooting, is of a very light construction, and very short; because the birds generally rise well within shot, and that the branches of trees, &c. may be less in the way of the gun's motion while taking aim. We have seen some guns made for this branch of shooting that have been little heavier than a large horse-pistol. With regard to such birds as are found on plains, or are aquatics, guns of a larger calibre, and more strongly fortified, so as to resist a large charge of powder without recoiling severely, are indispensably necessary. The selection of a gun must after all, depend on various circumstances, for instance, a powerful man, in the prime of life, and of a large stature, would be no ways incommoded by such a one, as would prove highly distressing to an elderly person, of a weak frame, and of a diminutive size. Again, we necessarily make a distinction according to the nature of the sport: hence, when shooting in a punt, or when laying wait for water-fowl, a heavy gun may be used. In truth, without a very strong charge, some of the more shy, or more full feathered birds are not easily brought down. Some experienced persons find that with a stout barrel, weighing from ten to fourteen pounds, they can bear the recoil of even two drachms of powder; which in an ordinary piece would produce, at least an highly unpleasant recoil, if not some damage to either the piece or the sportsman. Every barrel ought to be chambered; because the piece is thereby strengthened, and the force, or impetus, of the shot, considerably increased. With respect to the kind of chamber, a variety of opinions exist; for the most part purely theoretical, and in support of some favourite hypothesis, started by way of novelty, by some maker anxious to obtain celebrity. After mature consideration, we are rather disposed to accord with a number of old sportmen in commending the plain cylindrical chamber, made in the butt screw, or by a very small screw stump added to the butt of the piece: the latter being preferable in respect to security against lodging fire in the worm of the screw; but rather more expensive.

The lock of a gun is a most important object. It cannot well be too small and compact, provided space be allowed for the free movement of the several parts. We all know that the lock of a pistol will answer its purpose as well as that of a musket. The great consideration is, that friction should be avoided by every possible means, which is best effected by the most simple movements, and by keeping them clear from the plates. Every part subject to the action of another should be well steeled and hardened; and where practicable friction-rollers should be employed. The pan, above all things, ought to shut very close, and to spring up in a smart manner, when struck by the flint. The trigger should not be subject to action at half-cock; but at full-cock ought to draw with little resistance: at least, it should not require such force as might derange the aim, or delay the discharge.

Such guns as have double barrels, are commonly provided with a trigger for each lock; though some are made with but one trigger. In the former case, either barrel may be discharged at pleasure, which is not always the case in the latter mode of construction; which, though apparently more simple, is by no means so convenient. The

alleged reason of having but one is, that the interior is simplified, while the sportsman is less bewildered in regard to the choice of triggers, and in the application of the finger thereto; but we conceive, that no cool or expert sportsman is ever at a loss in those particulars.

We now come to speak of the sizes of shot in ordinary use, as they are appropriated to various kinds and sizes of birds: observing, that many old sportsmen and game-keepers consider it advantageous to mix No. 4, 5, 6, and 7, in nearly equal quantities. This, however, does not seem to be warranted. The application of particular sizes to corresponding purposes, appears to us more proper; nor can we reject that which rests on the solid basis of reason, in favour of a system but partially supported, even in words, and without a sufficient course of experiment under the eye of impartiality. We have, indeed, the assertions of various gentlemen, of the most candid dispositions, and versed in those experimental tests requisite to sanction a practice, whereby it should appear that no mixture should ever take place; but that where large, shy game is sought (such as wild geese, bustards, &c.) No. 1 should be used; or in default of that, No. 2: that where wild ducks, and other hard-feathered birds are in view, No. 3, or 4, should be used; that for hares, pheasants, and partridges, No. 4 and 5 ought to be employed; that for woodcocks, No. 6 and 7 suit well; while for snipes and quails, No. 7 and 8 answer admirably. As for ortolans, larks, &c. No. 9 and 10 should be used, where the birds are not very shy; otherwise No. 8.

From this it will be seen, that No. 4, 5, 6, and 7, certainly constitute the general expenditure of the regular sportsman; but we cannot, from that, deduce, that they ought to be mixed. However much we may differ, in the above point, from the Rev. W. B. Daniel, author of the celebrated "Rural Sports." Such is the opinion we entertain of that work, that we shall present our readers with the following passage extracted from his second volume. He gives the following table.

	Grains.
"One ounce of common shot, No. 4, contains	166
Charge for double gun	317
One ounce of patent shot, No. 4, contains	202
Charge for double gun	375

The difference of charge, between the patent, and the common shot, is therefore 58 grains in the ounce.

	Grains.
One ounce of No. 5, common shot, contains	230
Charge for ditto	437
One ounce of patent ditto	271
Charge for ditto	512
Difference 75 grains.	
One ounce of No. 6, common shot, contains	300
Charge for ditto	554
One ounce of patent ditto	327
Charge for ditto	630
Difference 76 grains.	
One ounce of No. 7, common shot, contains	363
Charge for ditto	708
One ounce of patent ditto	388
Charge of ditto	757
Difference 49 grains.	

MIXED SHOT.

One ounce of No. 4, 5, 6, common shot, contains	232
Charge for ditto	434
One ounce of patent ditto, No. 4, 5, 6	263
Charge for ditto	493
Difference 59 grains.	
One ounce of No. 5, 6, and 7, common shot, contain	297
Charge for ditto	582
One ounce of patent, No. 5, 6, 7	330
Charge for ditto	599
Difference 17 grains."	

Our readers cannot fail to perceive, that the word "charge" is, in the above case, purely arbitrary: we necessarily conclude, that Mr. Daniel found such answer well for the double barrel gun which he used; which might be of a large, or of as mall, bore. Taking the average, we compute his charges to weigh about 9 or 10, to the pound; and this we may, perhaps, find to be tolerably correct, as a standard on common occasions; since it is found, in general, that a bag of shot, weighing a quarter, *i. e.* 28 pounds, will make about 260 charges.

Mr. Daniel continues as follows:

"The smallest shot above mentioned, (*i. e.* No. 7), will kill at forty yards; the velocity of a charge of No. 7, being equal to one of No. 3, at that distance; and, since small shot fly thicker than large, in proportion to size, and, as there are many parts about the body of a bird, wherein a pellet

of No. 7 will affect its vitality, equal to a pellet of No. 2, the chances for using the former are multiplied in the marksman's favour; for it is the number, and not the magnitude of the particles, that kills on the spot. If sportsmen would be persuaded to use No. 5 and 6 in grouse and partridge, and No. 7 in woodcock-shooting, instead of No. 3 and 4; and No. 4 and 5 for black-game and pheasants, instead of No. 2 and 3, they would bring home one-third more game, and not destroy one bird more than usual. They who prefer large shot, and accustom themselves to fire at great distances, leave nearly as many languishing in the field, as immediately fall, whereas those that use small shot, and shoot fair, fill their bag, with little spoil or waste, beyond what they take with them from the field."

We derive much satisfaction from the support of so respectable an authority, and from the assurance of another veteran, in ornithologic devastation, who assures us, that for upwards of twenty years he never used any shot for field sport, above the size of No. 6, with which he has killed bustards and deer; the same authority further states, that for the ordinary birds of small game, such as snipes and quail, No. 8 was always found perfectly adequate. For geese, and in general for ducks, it was his constant practice to load with No. 2 or 3, according to the expanse of water. We are likewise indebted to the same authority for a kind of standard, by which sportsmen in general may be guided with propriety, which serves, at the same time, to supply a deficiency prevailing in all publications on this subject.

"Many persons are unable to estimate the proper charges of powder and shot for their respective pieces; it is true, some authors tell us, to be guided by the weight of the ball; but it often happens, that a ball is not at hand; and, when obtained, unless it fits exactly, and is perfectly spherical, will not determine the true dimensions of the bore. I have always found, that, with the best powder, a charge equal to a diameter and a half of the bore, was the best, that is, the most efficient quantity; that it impelled an equal quantity of shot, with great force; and that without causing too great a recoil. Thus if the bore were six-eighths of an inch, the load of powder, poured loosely into the piece, should raise the ram rod nine-eighths from an inch; or one inch and one-eighth. The wadding should be of thick leather, or felt (*i. e.* old hat) cut out with a machine; that should be rammed down firmly, but not so as to bruise the grains of powder. Then put in the same measure of shot, as you did of powder, and ram it down rather moderately, after covering with a second wadding as above. Observe, that shot will spread more or less in proportion to the force with which it is rammed down; the more it is rammed, the less it will diverge. The above mode of charging will cause the charge in a piece of three quarters of an inch bore, to occupy a depth of full two inches and a half in depth. Some, who have a great predilection for large charges may smile at the above quantity, which has, however, answered admirably with me, and will be found, under fair and repeated experiments, to be the most killing charge that can be used. But I must remark, that, owing to some fault in the construction, and especially if the vent be placed at all beyond the bottom of the barrel, some guns will recoil severely, even with the above moderate charge. When such is the case, I should recommend that the piece be chambered."

The foregoing perspicuous, mode of charging appears so reasonable, and is founded on so regular a computation, that we feel a confidence in urging all sportsmen to give it a fair trial; it is obviously moderate; therefore may be considered as devoid of danger. Upon that principle we could expatiate, at great length, regarding the highly culpable practice of carrying a piece full-cocked; also of letting it swing in such a direction as might cause the charge, in case of accident, to wound any person in the field. The muzzle ought always to be carried above the shoulder; and, in general, it ought to be the endeavour of every sportsman, to avoid every liability to endanger either himself, or any other person. However inconvenient stop locks may prove on some occasions, they nevertheless have the great recommendation of being on the safe side of the question: when a gun is put by in a situation accessible to other persons, even when unloaded, it ought to have the lock stopped, to prevent its being injured; but when a piece is loaded, which should never be the case, except under very pressing circumstances, due care ought to be taken to prevent its being in the hands of children, or of any but those for whose use it may be intended.

Having said thus much in regard to the construction or kinds of guns proper for

shooting in general, we shall proceed to state a few particulars relating to the various kinds of game generally sought, and to give the sportsman as much insight as our limits may allow, regarding the laws in force on the subject of shooting, &c.

The *Bustard* is the largest of our feathered game, the male sometimes weighing nearly thirty pounds, being in length (from beak to toe) nearly four feet, and expanding its wings so as to measure full nine feet between their tips. Some consider it to be gallinaceous, while others class it with the ostrich and cassowary. The bill is strong, and somewhat convex; the eyes red; head and neck ash-coloured; and on each side of the lower beak is a tuft of feathers from five to nine inches in length; in some countries of a beautiful jet black, but with us of a white or dun colour. The back is barred transversely with black and bright rust colour; the greater quill-feathers are brown, the belly white, the tail has twenty feathers, the middle ones barred with black; the legs are long, naked above the knees; it has no hind-toe (which is a peculiarity whereby this genus is distinguished, for there are innumerable varieties in different parts of the world) but has a callous process, serving as a heel. The female rarely exceeds twelve pounds in weight, and is not so strikingly marked as the male, and has no tufts under the bill; her colour is more dull, and she has not the reservoir, or water pouch, found within every male, and which is capable of containing from four to seven pints of water. This enables the bustard to remain for a long time on those immense plains, remote from water, where it is often found, and where the female lays her eggs, which are of a pale olive brown, sprinkled with dark spots; her nest is very soon made, being nothing more than a shallow hollow scraped in some dry place, especially in a turnip field, or in some dry stubble, or grass, whence she can see whatever approaches. Her own colour so much resembles the soil, that unless scented by dogs, she is often put up by persons who almost tread on her before she rises.

Bustards were formerly numerous in England, but now are only found in the south and east parts, particularly on the large downs of Yorkshire, and of Wiltshire and Dorsetshire; they are supposed to be extinct in Scotland. They very rarely wander more than thirty miles from their haunts, making very short flights, ry rapidly, and rising from the ground with considerable difficulty. Hence they have been frequently caught by greyhounds, after chases affording considerable diversion. It is evident, that for so heavy a bird, large shot must be necessary; especially when found on a plain, where it is extremely shy. Some have, however, been brought down with No. 6; but in such cases they have risen within a moderate distance. In aiming at the bustard with large shot, endeavour to strike under the wing; but if with any thing less than No. 2, you cannot do better than level just before his beak; so as to hit the head. This bird is by some called the floriken; in the east it is called the cherrnss.

The *Pheasant*, though not a native of England, nor indeed of Europe; for it was first brought from the banks of the Phasis in Asia Minor; has multiplied so extensively among us, as to form a very considerable object among the sporting world. The cocks sometimes weigh nearly four pounds; though, in general, not more than three: the hen is usually from eight to twelve ounces lighter. This bird is too well known to require description in respect to colour or figure. The wings of a pheasant are extremely weak; hence it can rarely fly half a mile. To this it is attributed that none are found on the new continent; though they are now very numerous throughout Europe, and in some parts of Africa, as well as in Asia. There are many varieties, such as the argus, of which the wings are all over dotted as with eyes; the golden, which is of a beautiful lustre green, marked with gold coloured specks of the most vivid appearance; the black, which is only found in India, where it is called the Moco, and is erroneously considered as appertaining to the crow-tribe.

The pheasant does not easily resign its wild habits; when it does, it seems to languish; it lays but few eggs, and is indifferent, or indeed at a loss, regarding its young; which are usually hatched and reared by a common hen on that account. When allowed to ramble, they multiply as quick as the means of subsistence may afford, and appears to thrive during even our most rigorous winters. They are extremely fond of ants; without which it is asserted by many, they will neither breed, nor remain where bred. In coppices abounding with haws, hips, and many other kinds of berries, the pheasant takes great delight; they also fatten a little upon acorns. They begin crowing about the middle of

March, when they will sometimes come into the farm-yards and tread the common hens; whence many assert the finest game fowls are produced; for the pheasant is remarkable for his spirit. One cock serves seven or eight hens. They are particularly fond of clover; especially when it stands for seed. In that they will, if undisturbed, make their nests; hence so many young and eggs are destroyed by the scythe.

In pheasant shooting most old sportsmen confine their aim to the cock birds, unless the game is extremely abundant; when it is often necessary to thin them, on account of the prodigious damage they do among ripening corn. When the corn is cut they will frequent the stubble, in search of the stray grains, until alarmed by the researches of sportsmen; at first they take to the hedge-rows, where they often lay extremely close, or wind in among the briars, so as to puzzle the spaniels, and to rise in a position adverse to the sportsman. After being several times put up, they take refuge in heavy woods, in which it is extremely difficult to make them take wing; there they run under the low bushes, and generally gain much upon the dogs, unless followed up with great spirit and activity. Aim at the head or wing, allowing a moderate advance for the birds flight, which is, at first, very rapid, but soon becomes languid, and is at all times very fluttering and noisy.

Sportsmen are sometimes deceived in regard to the sex of the bird they fire at; for a peculiarity obtains among pheasants which is perhaps little known; namely, that after a certain age the hen becomes barren, moults, and assumes the plumage of the cock. In this state she is subject to the jealousy of all the males, and has an unnatural bent towards the destruction of whatever eggs, of her own species, she can find.

Pheasant shooting commences on the first of October, and requires very well trained spaniels. Such as are strong in the chest and loins, with very short legs, are keen, obedient, and courageous, should be selected. Unless these qualities exist, the sportsman will meet with great mortification; his dogs will put up the birds at a great distance, and after having fatigued themselves, will hunt without spirit or discrimination. They will drive the pheasants up among the low boughs in the woods, and puzzle to no purpose. Spaniels that have a taint, however remote, of the hound, will be babblers, unsteady, and quit birds for hares. If good, you cannot have too many spaniels for pheasant shooting; but, if bad, every additional dog will prove an additional tormentor.

Mr. Daniel justly observes, "there are no fixed rules for beating coverts; this, however, ought to be a standing regulation, never to beat in a slovenly manner: a nide of pheasants are sometimes collected in a very small space, and in the middle of the day conceal themselves very close. In the early part of the season, pheasants prefer grassy, brambly, two and three year old slops; and it is lost labour to try higher growths: as the season advances, they will lie in clearer bottoms, especially among pits of water, which are sometimes found in woods. In winter, skirting the edges; and afterwards, by degrees, sinking deeper into the coverts, is, perhaps, where the game is not very plentiful, as good a mode as any. The haunt of the game that have been feeding in the adjoining fields, will thus probably be hit off; and it may, at least, serve to show whether there is game in the covert. If any of the spaniels are wide rangers, after traversing the wood well, always make a concluding circuit round the edge of it: depend upon getting shots, by this means, at those birds which may have ran, or flown, from the interior parts."

The *Partridge* is the most common species of field game in England. We have several varieties of this delicious bird, but those we call partridges are either grey or red; the latter is the biggest, and often perches upon trees: not being a native of our climate, but first introduced from the south of Spain, it is not very common, and is reared with some difficulty. The grey always keep on the ground, and form, by far, the greater part of the sportsman's success. The partridge, of whatever species, rarely remains long in the forest; but has its haunts under thick grown hedges, especially near to stubbles, wherein it feeds with its young so soon as the gleaners have performed their task. The partridge hatches a full month before the pheasant; therefore the former may be killed on the first of September. The propensity of the partridge to frequent open fields, subjects it to great danger, both from regular sportsmen and from poachers; the latter avail themselves of the alacrity with which this bird answers to the call, and by aid of a well broke setting dog, perhaps of no blood, but completely obedient, and keen after game, it is covered with the net, or led into a

labyrinth of springes. The male bird generally weighs nearly a pound, the female ordinarily about two or three ounces less. They pair about the middle, or end of February: there are always more cock, than hen-chicks: this produces great struggle for possession of mates, in which many are killed. The Duke of Kingston used to have his covies netted so soon as the birds began to pair, and thinned the number of cocks, and thereby had regular broods, which never happens when the hens are followed by two or more cocks; as she then drops her eggs in different places, and cannot, of course, hatch them in any numbers. The hens lay on the ground, among a few bents and leaves scraped together, usually within some hollow made by the tread of a horse, or by the removal of some large stone or clod. Partridges are very amorous and prolific: they ordinarily lay from sixteen to twenty eggs, and often may be seen leading their young in covies of seven or eight brace. In 1793, on a farm occupied by Mr. Pratt, near Terling, in Essex, a nest was found in a fallow, containing thirty-three eggs; of these twenty-three were hatched, and the birds fledged; four more had nine birds in them; the eggs were piled in a very curious manner by the hen, which covered them all. The above instance of fecundity, though rare, is not singular; for in June, 1801, at the seat of Mr. Clarke, Walton Place, Northumberland, a nest was found in a plantation, containing thirty-three eggs; and in 1798, one was found in a wheat-field, in Somersetshire, with twenty-eight eggs. In the year 1788, a partridge was found sitting in the heart of an oak pollard, many feet from the ground; although a stile was fixed into the tree, and persons were perpetually passing by. She hatched sixteen eggs, and assisted her chicks to scramble down among the twigs, until they were all in safety on the grass.

While the chicks are young, and unable to fly, the old birds attend to them very assiduously; at the least alarm they all shelter under the hen's wings, or perhaps under those of the cock. When a dog, &c. breaks in, the cock pretends to be in a state of debility, and separates from the hen, which leads the brood away; the dog is, thus led astray. Partridges will also fly at a kite that hovers over their young, in defence of which they are extremely daring and indefatigable. These birds often pair with barn-door fowls; but are by no means prone to domestication. It is probably owing to the intermixture, that covies have been seen pied, party-coloured, or white.

In shooting partridges, pointers and setters are usually employed: they should be thoroughly staunch, and perfectly under command. The best pointers are of a tall stature, rather light than heavy, in the limbs, with small heads, deep chests, and lank about the abdomen. The more white about them, the better they will be distinguished, especially towards the close of day. All dogs that stand, or set, ought to quarter their ground well, and should naturally turn to windward; so as neither to blink, nor to run up, the birds. Though setters are much used by poachers, yet many gentlemen prefer them to pointers; but they answer for low coverts only, such as clover and stubbles. The poachers work by night, and prefer open countries to such as are enclosed; especially when they use the tunnel-net. To prevent them from catching birds with that destructive machine, a few young partridges should be got early in the season; these having their bearing claws cut off, cannot run, but always spring, and induce the whole covey to rise. To obviate the ordinary mode of netting birds at night, the stubbles should be bushed; that is, a number of strips of aglantine, dog-rose, or even large thistles, should be laid about in the fields; that the net may be intercepted, and the birds be alarmed.

With regard to the variety of partridges, it would be almost endless to describe them: in some countries, they are of a fine black on the breast, where each feather bears a white spot about the size of a pea; the rest of the body being strongly marked with game-feathers. The red-legged partridge is a native of hot climates; it is a beautiful bird, grows very large, and is peculiarly marked with yellow near the eyes, while the breast bears a large dark-coloured crescent. Whatever is of a red, or glowing colour, attracts these birds greatly; hence they are very keen in swallowing red-hot cinders, &c. which, however, soon kill them. This bird is possessed of great speed, and after running for some distance, generally into a covert, will crouch, and allow the dogs to be on the point of seizing, before he will take wing. There are very few of this breed in England; what there are seem to be purely accidental. When wounded, they go to ground in rabbit burrows, &c.

The *Black-grouse*, which is a species of partridge, is found chiefly on extensive woods in the northern parts of Britain;

there it is found in immense abundance. Some are also seen in Hampshire: it is peculiarly attached to woody and mountainous situations; especially where the hether grows large, and where juniper bushes abound. The black-grouse perch on trees; they never pair; but when the cocks crow, and clap their wings, the hens fly to them from all quarters. The male weighs full two pounds, in general; the females rather less. They live under the snow during great part of winter; but always take the precaution of eating their fill of birch catkins, before they shelter there. Cherries and pease are deleterious to this bird.

The *Red-grouse*, *Moor-cock*, or *Red-game*. This bird lives chiefly on the extensive moors in North Britain, and in the northern parts of England; also in some of the Welsh counties. It is supposed to be a native of Britain, and, indeed, to be peculiar to our islands. The male usually weighs about eighteen ounces; the female about fourteen. They pair in the spring, and the broods flock together during winter; being then remarkably vigilant and shy. They usually resort to the summits of hills covered with hether, juniper, bilberry, &c. it is necessary to draw them so soon as killed; else they speedily become tainted. Setters are better than pointers for following red-grouse, on account of their long hair, which protects them from the action of the coverts; but, to enable their acting with vigour, they must often be supplied with water; which, on many moors, will not be readily found. This sport commences on the 12th of August. In 1801, a gentleman in Invernessshire shot fifty-two brace of moor-game in one day, all single, and on the wing.

The *White-grouse*, *White-game*, or *Ptarmagan*, is about the same size as the red-grouse; but its plumage is of a pale brown, or ash colour, mottled with dusky spots and minute bars; the head and neck have brood-bars of black, rust colour, and white; the wings are white, as is the belly. The males are beautifully plumed. In winter the ptarmagan is nearly white; they are feathered to the very claws, and have strong hairs growing upon their soles. This bird seems to delight in a cold temperature; always following the snow, (even to the summits of the Grampians), in which it burrows: it carefully avoids the solar rays. The Greenlanders catch them by dropping loops over their necks, as they sit at the mouths of their burrows, or on stones of their own colour, which they carefully select to roost upon during bleak, dull weather. In Nova Scotia, they are called "birch-partridges:" in that quarter their feathers grow double, during the cold months.

The *Quail* is but little known in England: it may be considered as a small kind of partridge; but it is a bird of passage. There are supposed to be at least two hundred varieties; though we rarely see more than two kinds; *viz.* the brown, and the brindled; the latter are, however, extremely scarce. Quails, in our climate, are, in their habits, pretty similar to partridges; but, where they abound, may be seen in bevies, consisting of more than a hundred birds. They are easily domesticated, but for a while only: at the period of migration they invariably disappear; it is said, they sometimes return to their former homes. They sleep chiefly during the day, and at night, ramble to any place where corn is ripe, or has been cut: being extremely vigilant, and running very fast, it is not easy to put them up. They are peculiarly litigious, and rarely desist until disabled. They will not visit any country where herbage is scarce, or deficient in verdure. They make no nest, but scrape together any rubbish, or even sit in small hollows, without any preparation whatever. The young are very hardy, and, in a week, shift for themselves: usually about ten eggs are found in a nest. As quails take very short flights, and those generally straight, they are excellent practice for the young sportsman: very small shot will kill them.

Corn-crakes, *Land-rails*, or *Daker-hens*, are always found among corn, grass, broom, or furze: they migrate before winter. The peculiar note of this bird subjects it to immediate discovery; the repeated sound of *crek*, *crek*, *crek*, (somewhat similar to springing the edges of a fine comb), from the thickest part of our meadows, is sure to announce its arrival; generally about the middle of May. It lays about fifteen or twenty eggs; the young birds are covered with a black down, and are very active. Corn-crakes are of a strong scent, and cause dogs to remain for a long time in search; their unwillingness to rise occasions many to be caught by hand, they will not fly until absolutely compelled; and then very heavily, with pendent legs, and to a short distance; but they run very fast. When flitted, they usually perch in a hedge. They mix much

with quails, and, like them, weigh from six to eight ounces.

Ruffs and Reeves are so diversified in colour, that scarcely two are ever found of the same appearance. The former are the males, and may be known by the ruffs about their throats: they are generally more numerous than the reeves, which are the females. The ruff grows large, but is very light; rarely reaching beyond seven ounces; though extending about two feet between the tips of the wings. These birds are found early in the spring, in the fens of Lincolnshire, and other low countries, but retire, no one knows whither, about Michaelmas. The reeves lay four white eggs, marked with rusty spots.

Plovers are of various kinds, but the sportsman pursues only the golden, the grey, and the peewhit, or lapwing. They generally weigh from seven to nine ounces, and visit us only from October to March; and then in no great numbers. Look for them in ploughed fields. Few are shot, but many are netted in green corn-fields near to water, to which they always resort after a meal, to wash their beaks: their flesh is peculiarly delicate, and the eggs are sold by the London poulterers at the enormous price of four shillings per dozen.

The *Woodcock* is a bird of passage, arriving among us about Michaelmas, and retiring about March: they fly only by night. In the moonlights of November and December, they may be heard passing from about ten till four; they are, however, entirely guided by the wind: they are invariably preceded by the red-wing, and followed by the Royston crow. In the spring, when the wind is easterly, the woodcocks, assemble on our eastern coasts, linger among the furze, waiting for a westerly change, and may then be killed in great numbers. They rarely stay long in a place, but proceed from one spring-head to another; thrusting their long beaks into the slime, and sucking the worms by which they are nourished. They are particularly fond of such rills as lie within coppices and heavy woods: in such they take very short flights when rouzed, and will dog among the boughs in a surprising manner. It requires an excellent brace of spaniels, short rangers, and extremly vigorous, for this branch of shooting: great numbers are caught in springes, set on the borders of lakes, &c. Woodcocks generally weigh from twelve to fourteen ounces; but those that arrive early in the season are the largest. When a woodcock rises, he invariably quits his trail, so that nothing is ever found in the intestine. It should be remarked, that some persons seek for woodcocks with pointers to whose necks small bells are suspended to rouze the birds, which sometimes are either unable, or averse, to move; but we cannot think such a practice by any means likely to succeed. A person who marks well is a great aid in following this diversion.

The *Snipe* is divided into three classes; the common, the jack, and the great. They all frequent our marshes in the winter-season, and are sometimes very numerous: some years since the Duke of Marlborough's game-keeper killed twenty-two snipes at one shot. The several kinds weigh from two to seven ounces; but the great snipe is solitary, and has a beautifully coloured wing; whence it is by many called the "painted snipe." During very cold weather, the snipes are apt to be on the wing; but in the middle of the day, especially when the sun is bright, will lay so as even to be trod upon rather than flit. These birds frequent marshes, and are to be found on the banks of weedy, foul ditches, particularly where the soil is fat, and that worms abound.

All the varieties of water-fowl, such as *Geese* of various descriptions, *Ducks* of ditto, *Widgeons*, *Teal*, *Divers*, *Pentails*, *Pochards*, &c. frequent our marshes chiefly from October to February, and in general must be pursued in boats. To be equipped for this sport, it is essentially requisite to be well clothed; flannel shirt and drawers, with additional exterior and interior garments, will be found indispensible when polling about the marshes, or when stationed in a punt on the borders of the oozes. Water-proof boots are necessary, as are woollen gambadoes drawing up to the middle of the thigh at least. A cap made of skin must be worn, as the fowls will not approach persons wearing hats, of which they seem to entertain a peculiar dread. It is necessary, when firing at them while on the wing, to aim well before them; it being ascertained that they fly at the rate of ninety miles within the hour! During sharp frosts the sportsmen may, early in the morning, find excellent diversion where the brooks are only partially frozen: wherever there is a warm spring, there will he find fowls, provided the spot be at all sequestered, or is not overlooked. Immense numbers of water-fowls are caught in decoys, by means of some of their own spe-

cies trained to deception: they lead them into narrow passages, netted in a secure manner, near which a man is completely hidden, but who, showing himself suddenly, causes the deluded followers to remain in captivity, while the decoy birds all retreat, and escape the fatal issue.

We shall close what relates to the feathered game with the following glossary of technical terms; many are now obsolete, but as they may afford the means of arriving at the meaning of old authors, we give them a place.

A sege of herons, and of bitterns; an herd of swans, of cranes, and of curlews; a dropping of shelldrakes; a spring of teals; a covert of coots; a gaggle of geese; a badelynge of ducks; a sord, or sute, of mallards; a muster of peacocks; a nye of pheasants; a covey of partridges; a bevy of quails; a congregation of plovers; a flight of doves; a dule of turkies; a walk of snipes; a fall of woodcocks; a brood of hens; a building of rooks, a murmurration of starlings; an exaltation of larks; a flight of swallows; a host of sparrows; a watch of nightingales; and a charm of goldfinches.

Some of the above are no doubt very applicable; but, in general, they are rather quaint than appropriate. The language of fowlers, like that of the turf, abounds with cant, on the exact application of which many pride themselves greatly.

Coursing is generally confined to the pursuit of hares, in which great amusement is afforded to those who are not sufficiently active to join in fox-hunting. Formerly deer and foxes were coursed, but at this date we have no instances of such chaces, except in the Highlands of Scotland, and in some parts of Ireland, where many braces of grey-hounds are occasionally posted in various directions, as relays to such as may first be slipped after the roe-buck. The laws of coursing were established by the Duke of Norfolk, in Queen Elizabeth's reign, and were agreed to by the nobility, who then followed the diversion: they have been held authentic ever since, and are as follow.

1. The feuterer, or person that lets loose the dogs, was to receive those into his leash that were matched to run together; with these he was to follow the hare-finder, until he should come to the form: no person else being allowed to be on either side, or less than forty yards in the rear of the dogs. 2. A hare was not to be coursed with more than a brace of greyhounds. 3. The hare-finder was to give the hare three "So-ho's," before he put her from her form, that the attention of the dogs might be rouzed. 4. The hare was to have twelve score yards law before the dogs were loosed; unless the proximity of any cover should render such indulgence a prejudice to the chace. 5. The dog that gave the first turn during the course, if there was neither cote, slip, nor wrench, was the winner: a cote is where a greyhound goes endways by his fellow, and gives the hare a turn. 6. A cote was reckoned as two turns, and two trippings, or jerkings, made a cote: if the hare did not turn quite about, she made only a wrench; two of which stood for a turn. 7. If no cotes were made, but that one served the other at turning, then he that gave the hare most turns was the winner: but if the turns were equal, the dog that bore the hare won. 8. If one dog turned, and the other bore the hare, the latter won. 9. A go by, or bearing the hare, was equivalent to two turns. 10. If neither dog turned the hare, he that last led to cover won. 11. If one dog turned the hare, served, and turned her again, it was as much as a cote; for a cote was equal to two turns. 12. If all the course was equal, the dog that bore the hare won. 13. If the hare was not borne, the course was adjudged dead. 14. If a dog fell in coursing, and yet performed his part, he might challenge a turn more than he gave. 15. If a dog turned the hare, served himself, and gave divers cotes, and yet, in the end, stood still in the field; the other dog, if he ran the hare to cover, though he gave no turn, was adjudged the winner. In fact, no dog that gave up could win. 16. If by any accident a dog was rode over in his course, or improperly baulked, the course was void, and he who did the mischief was to make due reparation. 17. If a dog gave the first and last turn, and there was no other advantage, or reckoning, between them, he that gave the odd turn won. (Here, we beg leave to observe, is an opening for much misconception). 18. He that came in first at the death took up the hare, saved her from being torn, cherished the dogs, and cleared their mouths from the wool, was adjudged to have the hare, as the reward of his spirit and assiduity. 19. The judges of the course were to decide all points before they quitted the field. 20. No person could claim any prize or privilege, but under sanction of the judges of the field.

These are certainly very reasonable regulations, and are applicable to all the modern forms of coursing. But the mode now in use is far more simple. A number of horsemen form a line, at about three or four yards asunder, and having a brace of dogs loose at the heels of their owner, or divided in the line; the cavalcade beat the covers, which should be very low, such as hether, or grass, or fallow lands, and all look out sharp for hares sitting. When a hare is seen, the call "Soho" gives notice to the whole party, which then file off so as to give the hare that offset which may appear most favourable to the sport. The dogs are kept back, until the hare is roused from her form, and has some law, when a horseman gallops after her, calling "Hilloo," "Hilloo," so as to lay the dogs in; after which the whole party refrain from crossing her path, and in general ride at some distance behind, so as to avoid checking the course: but in case the dogs should lose the hare among any high grass, &c. one, or more horsemen follow her, and again cheer the dogs, until they have her again in view.

Some most extraordinary courses have been made: in 1800 a brace of greyhounds ran a hare for twelve minutes, during which she was often turned, and died before the dogs, at four miles from the spot whence she started. Greyhounds have ran with such violence against each other in coursing, that both have been killed on the spot. The finest coursing is in Yorkshire, and Wiltshire, in both which counties remarkable fine greyhounds are bred. The following old saying is, perhaps, as good a description as can be given, in few words, of the principal points in a well formed greyhound.

"Head like snake,
Neck like drake,
Back like beam, (*i. e.* cambered, or arched.)
Side like bream, (*i. e.* deep chested, and finely keeled.)
Tail like rat,
Foot like cat."

The best age to enter a dog is about a year; some enter them when only ten months old; but one or two severe courses generally ruin them: in truth, coursing is too laborious for any dog not fully formed, and possessed of good constitution. Greyhounds are very delicate while young; and are, perhaps, of all dogs most subject to distemper. They are not full grown until two years old. The bitches generally have most speed, and the dogs most strength. To give them good wind, biscuit soaked in good broth is their best diet; but no food should be given for four hours, at least, before a dog is to run.

Hare-hunting generally commences so soon as all the crops are fairly off the ground, and that the leverets, or young hares, have acquired strength enough to stand before the hounds. The dogs mostly employed in this sport, are the north country beagle, which is nimble and vigorous, pursues a hare with impetuosity, gives her no time to double; and, if the scent lies high, will easily run down two brace before dinner. These dogs are kept by the dashing class of sportsmen; who are usually well mounted, and pride themselves on the quantity of game killed in a day. But the breed mostly used for hare-hunting are the deep tongued, thick-lipped, broad and long-hung, southern hounds. These ordinarily give a long chace, and succeed by dint of perseverance; for their pace is rather slow, but their cry is peculiarly musical.

A middle breed is sometimes seen, having rough wire-haired backs, thick quarters, and rather thin shoulders: many suppose it to have been obtained by a cross with the Pomeranian dog, or the Russian hound. The whole may be mixed without disadvantage. There is another sort preferred from their acuteness of smelling, and because they are easily subsisted; but they are apt to be great chatterers: these are very small, fine boned, long eared, and peculiarly handsome in their fore-quarters. The late Colonel Hardy had a cry, consisting of about eleven couples of this diminutive race, which used to be carried to and from the field in a pair of panniers, slung across a horse. They were all stolen one night, together with the panniers, and not the least trace was afforded whereby to discover either the robbers or their booty. As that gentleman resided not far from the coast, it is probable his pigmy pack were sentenced to transportation beyond sea; and, no doubt, fetched a good price on the continent.

The nature of the country should determine with regard to the choice of hounds. Where the dogs are very fleet, and the country well enclosed, they act nearly on a par with slower hounds in an open district. When a dog is too fleet for the pack, he should be loaded with a collar, filled with small shot, so as to make him carry weight,

and bring him down to the level of speed. When a hound is too slow he should be drawn, unless he happens to be peculiarly well gifted; in which case, though he will constantly tail (or lag,) he will rarely fail when the precursors are at fault, to dash through them without losing the scent, and thus set the pack on the cry again.

The choice of a hound, of whatever breed, may be summed up in a few words: select the dog of a middle size, broad backed, wide nostrils, capacious and deep chest, fillets great and high, haunches large, hams straight, well-curved rump, round feet with firm dry soles, large claws, broad ears, full eyes, and a heavy upper lip. But with all this form, he will not be worth a groat, if his olfactory powers be defective, if he be given to babble, or that he steals away after his game without giving tongue. Many dogs, however, of great value, run mute, but they possess fine action, and always show themselves to be on scent, or eventually whimper as they hit it off.

Young hounds should always be trained to some particular branch of sporting, and not be suffered, as is too often the case, to hunt either foxes or hares, as chance may present; such dogs are always unsteady and unmanageable. Enter the pups at a year old, if possible, in a country where the runs are not severe; but always have an eye to training them in a close or open country, according as that part is where they are permanently to hunt: for a dog taken from an open to a close country, or *vice versa*, will never hunt with so much spirit as those trained on the spot.

It is remarkable that hares run hardest, and puzzle most at the full of the moon; they have always more scent in going to, than from, their forms; both because they are then warmer, and because they usually approach their seats slower than they quit them: but a hare generally springs into her form from some distance. When the huntsman is certain of a hare in any particular covert, he should lead his dogs compactly thereto, and give her the chance of going off with all advantage: he must never baulk her by crossing her usual sortie, for in such case she would be dismayed, and give but little sport. It is, indeed, usually best to alarm the hare by the gradual approach of the pack, which she will soon wind, or hear, and thus to give her a fair start, that she may go off deliberately, and not be blown by an early view.

Hares generally make a circular tour; and, for the most part, endeavour to return to their haunts. Hence many a fine chace has been seen from a rising ground. It sometimes happens that a hare "flies the country;" that is, goes off straight: when this happens, the hare is generally a rambler from some other covert, and exerts all her speed to return thereto. The first ring a hare makes ordinarily shows where the chace will lay; for all her endeavours will be exerted to double upon her former track, and to cross the scent, so as to throw the dogs out. Such is the cunning of this animal, that it will, when close pursued, leap into high bushes, and remain there, although surrounded by dogs and huntsmen: in this manner many escape. We have heard of a hare leaping into a road-waggon, and thus evading her followers completely. Some when running against the wind stop short, and after allowing the hounds to pass, return secretly to their forms: this trick succeeds best when the dogs are fresh and impetuous.

The limits of our work not allowing us to enter upon all the minutia of hare-hunting, we must conclude this part of our subject with observing, that the most successful huntsmen always make the least noise, and not only keep others back, but invariably allow a good interval between the dogs and their own horses. By this means they often discover those tricks which a hare is apt to practise, and which with less cautious persons very generally insure her safety.

Fox-hunting is a diversion requiring considerable powers both in the rider and in his steed: the extent of ground traversed on some occasions, and that too at more than a moderate pace, establishes the necessity for a rare combination of strength, activity, courage, and perseverance, in those who follow this laborious sport.

There are three varieties of fox with us, all differing in form but not in colour; except the cur-fox, the tip of whose tail is black. They are distinguished by the names of the greyhound-fox, which is the tallest and boldest, is found chiefly in the mountainous parts of England and Scotland, and will attack a full grown sheep. The mastiff fox is rather less, but his limbs are strongly formed; his shape is altogether more compact, and he is perhaps as stout as the species above-mentioned: this variety is not very common. The kind mostly found by sportsmen is the cur-fox, which, though of smaller stature than either of the foregoing, is most pernicious to game, and

infests all places where poultry, or any animals it can master, are kept. All foxes are peculiarly alarmed by the discharge of fire-arms, and quit those earths which smell of gunpowder: hence, fumigating with sulphur is resorted to as the certain means of expulsion. When pressed by hunger, foxes will eat snails, slugs, beetles, berries of various kinds, crabs, shrimps, &c. and sometimes carrion; but they prefer warm flesh, and that too of their own killing.

The fox knows how to secure a good asylum, either by digging holes, or by following crevices among rocks, roots of trees, &c.; with many apertures, so as to favour escape, or entrance, when in danger; or eventually, he steals in the den of some badger, occasioning that animal to quit it, and then enlarges, or alters, the interior according to his own fancy. When chaced, he generally flies the country to some strong covert, endeavouring to shelter himself in some other earths; in which, however, he cannot remain when heated with running; but he sometimes succeeds by swimming across streams, or by climbing trees, or to the tops of barns, &c. Sometimes, though not often, he will lead back to his own earths, where he may expect certain death.

It is usual, when the fox-hounds are to go out, to send out the earth-stoppers during the preceding night: these repair to the several haunts, and close the entrances while the foxes are abroad in search of prey. The cunning animal finding the work of man about his premises, retires to some furze, hether, or coppice, not far off, where he is sure to be started by the dogs; and to be followed, indeed sometimes pointed out, by the jays, blackbirds, crows, magpies, and other birds, which consider him as their common enemy. When attacked he fights in silence, but with astonishing courage, regardless of pain, and rarely quitting his hold. When seized by the hounds it is rarely that he cries out; though he snarls and snaps with peculiar expression, and indescribable ferocity.

It is highly necessary in training fox-hounds, to keep them entirely to the pursuit of foxes: if suffered once to follow a hare, their staunchness will be in danger of diminution. A hound for this sport should be of rather a large size, full of blood, light but strong in the limbs, great speed, and of distinguished perseverance. If deficient in either of these requisites he must be drawn. He may make a good harrier, under certain circumstances, but will be a great detriment to the fox-pack. Nor is the keenness of scent an object of less importance; indeed, it is of more moment than among harriers; for the fox will play off an infinity of devices, especially that of running on a dusty road, crossing broad waters, springing over wide ditches, passing along the copings of park-walls, &c. that acquire an acute sense of smelling to defeat: add to this, he is often a mile a-head of the hounds, whereby the trail loses greatly of its strength.

In following fox-hounds, the sportsman has little time for deliberation: he must keep up as well as he can, taking care to keep the cry in hearing, and avoiding leaps and scrambles as much as he can. It is true, this doctrine is by many held to be effeminate, and unbecoming the keen hunter; but it is the way to be in at the death, and to enjoy the chase without injuring the horse. Fox-hounds spread much more than harriers, on account of the diversity of country they run through: hence there is often a mile, or more, between the first and last dog; considering even the hindmost as well laid in, and rejecting such as are faulty. With regard to the extent of riders, no computation can be offered; it sometimes reaching from the place where the game started, to where it died, or was lost.

Foxes are wonderfully sagacious; they have been carried sixty and seventy miles in hampers, for the purpose of being hunted by some distant pack; and after escaping, in various successive instances, have been retaken at their original haunts. This seems to prove that foxes are great ramblers, and are in general well acquainted with a very large tract around their usual haunts. Perhaps the following may show their great cunning better than any instance hitherto offered to the public: it is taken from Daniel's "Rural Sports," and is considered to be strictly correct. "A fox being hard run took shelter under the covering of a well, and by the endeavours used to extricate him, was precipitated to the bottom, a depth of one hundred feet. The bucket was let down, he laid hold of it, and was drawn up for some way, when he again fell. The bucket being let down a second time, he secured his situation in it, was drawn up, again turned off, and fairly beat the hounds." This occurrence is said to be well known at Imber, in Wiltshire, where the well is often shown to the curious.

Wolf-hunting, fortunately for the inhabitants of Britain and Ireland, is now be-

come obsolete, by the total extinction of that animal among us. Wolf-dogs are, however, retained by some gentlemen as curiosities: they are said to be the most faithful animals of the canine race, and possessed of wonderful powers in regard to hitting off a cold scent.

Boar-hunting forms no part of the British field sports, though pursued in some parts of the continent with the utmost keenness, and on a grand scale. In Germany, especially, the chase after the wild-boar, forms a grand feature of national sports, and is attended with great preparation and expense. The haunts of those animals are first ascertained, after which a host of hunters throng to the woods, some mounted, and some on foot, to rouze and attack the bristled game. All are armed from head to foot, and take care to have some lusty trees at hand, behind which they may take refuge when the boar charges. The danger arises, however, less from the animal than from the number of random shots fired at him, without any attention to what persons may be in the line of aim; numbers are thus wounded, and even killed outright, in this desperate species of pastime.

Nor is *Tyger-hunting* attended with less risk; for, in addition to the above negligence, the danger of being ran away with by the elephant on which the sportsman must be mounted, is to be considered. The tyger is usually roused from either the jungle of underwood, or from his haunt among grass of a prodigious height, covering immense tracts of land. Few elephants can be brought to face him; and, when they can, it often happens that the tyger's claws repel the attack, or that by springing upon the back of the stupendous quadruped, he dislodges the driver, or the sportsman and his attendant. It is, however, a fact that fewer persons are destroyed, or maimed, in either boar or tyger-hunting, than meet their deaths in fox-hunting. But even that hazardous diversion may be considered as safe when compared with

Stag-hunting, in which great speed is indispensable, and no hesitation can be admitted by any person desirous of witnessing the various bold and elegant variations in the stag's career. For this sport, hounds of large stature, great powers, and extraordinary courage, are indispensable; for when the stag sails, (*i.e.* takes to the water) he must be followed without delay: when at bay, (*i.e.* standing on his defence, probably with his rump towards a tree) he will make desperate attacks on his pursuers; frequently tossing many of the dogs, and goring the horses of such as approach him incautiously. Many hunt stags with what are called stop-hounds; which implies, that whenever the stag is to be saved, the huntsman heads the pack and throws a pole, on which the whole desist from the pursuit. This may be needful where the game is not abundant, but requires much management and great assiduity to effect.

We fear the taxes laid on horses and dogs, added to the expense of the necessary certificate, trench deeply on the enjoyment of rural sports, by those who are qualified, and operate considerably in favour of poachers, who thus have the game, in a measure, preserved for them; and are sure of a sale for their ill-gotten gains, among families which formerly could always obtain a hare, or a brace of birds, without expense, and the result of a healthy mode of amusement.

SPOTS, in astronomy, certain places of the Sun's or Moon's disc, observed to be either more bright or darker than the rest, and accordingly called faculæ and maculæ. See FACULÆ and MACULÆ.

SPRAT. See CLUPEA.

SPRAY, the sprinkling or foam of the sea, which is driven from the top of a wave in stormy weather. It differs from what sailors call spoon-drift, as being blown occasionally from the broken surface of a high wave; whereas the latter continues to fly horizontally along the sea, without intermission during the excess of the tempest or hurricane.

SPRING, in natural history, a fountain or source of water, rising out of the ground. Various have been the opinions of philosophers concerning the origin of springs; but those which deserve notice are only the three following ones: 1. That the sea-water is conveyed through subterraneous ducts, or canals, to the places where the springs flow out of the earth: but as it is impossible that the water should be thus conveyed to the tops of mountains, since it cannot rise higher than the surface, some have had recourse to subterraneous heats; by which being rarified, it is supposed to ascend in vapours through the bowels of the mountains. But as no sufficient proof is brought of the existence of these central heats, or of caverns in the mountains big enough to let the vapours ascend, supposing such heats, we shall not take up our reader's time with a formal refutation of this hypothesis.

2. As to those who advance the capillary hypothesis, or suppose the water to rise from the depths of the sea through the porous parts of the earth, as it rises in capillary tubes, or through sand or ashes, they seem not to consider one principal property of this kind of tube, or this sort of attraction: for though the water rise to the top of the tube or sand, yet will it rise no higher, because it is by the attraction of the parts above that the fluid rises, and where that is wanting it can rise no further. Therefore, though the waters of the sea may be drawn into the substance of the earth by attraction, yet it can never be raised by this means into a cistern, or cavity, to become the source of springs. 3. The third hypothesis is that of the sagacious naturalist, Dr. Halley, who supposes the true sources of springs to be melted snow, rain-water, dew, and vapours condensed.

Now in order to prove that the vapours raised by the heat of the sun from the surface of the seas, lakes, and rivers are abundantly sufficient to supply the springs and rivers with fresh water, the Doctor made the following experiment: he took a vessel of water, made of the same degree of saltness with that of the sea, by means of the hydrometer; and having placed a thermometer in it, he brought it, by means of a pan of coals, to the same degree of heat with that of the air in the hottest summer. He then placed this vessel, with the thermometer in it, in one scale, and nicely counterpoised it with weights in the other: after two hours, he found that about the sixtieth part of an inch was gone off in vapour, and consequently in twelve hours, the length of a natural day, one tenth of an inch would have been evaporated. From this experiment it follows, that every ten square inches of the surface of the water yield a cubic inch of water in vapour per day, every square mile 6,914 tons, and every square degree (or 69 English miles) 33 millions of tons. Now, if we suppose the Mediterranean to be 40 degrees long, and 4 broad at a medium, which is the least that can be supposed, its surface will be 160 square degrees, from whence there will evaporate 5280 millions of tons per day, in the summer time. The Mediterranean receives water from the nine great rivers following, viz. the Iberus, the Rhine, the Tyber, the Po, the Danube, the Neister, the Borysthenes, the Tanais, and the Nile; all the rest being small, and their water inconsiderable. Now let us suppose that each of these rivers conveys ten times as much water to the sea as the Thames; which, as is observed, yields daily, 76,032,000 cubic feet, which is equal to 203 millions of tons; and therefore all the nine rivers will produce 1827 millions of tons; which is little more than one third of the quantity evaporated each day from the sea. The prodigious quantity of water remaining, the doctor allows to rains, which fall again into the seas, and for the uses of vegetation, &c. As to the manner in which these waters are collected, so as to form reservoirs for the different kinds of springs, it seems to be this: the tops of mountains, in general, abound with cavities, and subterraneous caverns formed by nature to serve as reservoirs; and their pointed summits, which seem to pierce the clouds, stop those vapours which fluctuate in the atmosphere, and being constipated thereby, they precipitate in water, and by their gravity easily penetrate through beds of sand and lighter earth, till they are stopped in their descent by more dense strata, as beds of clay, stone, &c. where they form a bason or cavern, and work a passage horizontally, and issue out at the side of the mountain. Many of these springs running down by the vallies, between the ridges of hills, and uniting their streams, form rivulets or brooks; and many of these, again, uniting on the plain, become a river.

Springs are either such as run continually, called perennial; or such as run only for a time, and at certain seasons of the year, and therefore called temporary springs. Others again are called intermitting springs, because they flow and then stop, and flow and stop again: and, finally, reciprocating springs, whose waters rise and fall, or flow and ebb, by regular intervals. To account for these differences in springs, see Hydraulics.

Spring, in mechanics, denotes a thin piece of tempered steel, or other elastic substance; which, being wound up, serves to put several machines in motion by its elasticity, or endeavour to unbend itself; such is the spring of a clock, watch, and the like. The spring of a lock, gun, pistol, or the like, is a piece of steel, violently bent; which, being set at liberty, beats back the bolt of the lock, or strikes down the cock.

Spring, in naval affairs, a crack running transversely, or obliquely, through any part of a mast or yard, so as to render it unsafe to carry the usual quantity of sail thereon. Spring is also a rope passed out of a ship's

stern, and attached to a cable proceeding from her bow when she lies at anchor. It is usually performed to bring the ship's broadside or battery of cannon to bear upon some distant object, as another ship, a fortress on the coast, &c. When a ship rides by anchors which are only attached to one end, she will move like a weather-cock, according to the direction of the wind or tide. Now if a rope be extended from the other end to the same anchor, it is evident that by slackening one of these ropes, and keeping fast the other, her side will lie more or less obliquely to the wind or tide, as occasion may require, so as to be opposed to any distant object to the right or left. For instance, if a ship ride with her head northerly, and it is required to cannonade a fortress lying on the south or south-east, a hawser is run out of the stern, and being carried forward without her fid, is attached to the cable at a competent distance a-head of the ship; the hawser is then tightened by the capstan or tackles, and the cable being slackened, the ship immediately turns her side towards the object intended to be battered.

SPRIT, in naval affairs, a small boom or pole which crosses the sail of a boat diagonally from the mast to the upper aftmost corner, which it is used to extend and elevate; the lower end of the sprit rests in a sort of wreath, which encircles the mast at that place.

SPRUCE *beer*, a cheap and wholesome liquor, which is thus made: take of water sixteen gallons, and boil the half of it. Put the water thus boiled, while in full heat, to the reserved cold part, which should be previously put into a barrel or other vessel; then add sixteen pounds of treacle or molasses, with a few table spoonfuls of the essence of spruce, stirring the whole well together; add half a pint of yeast, and keep it in a temperate situation, with the bunghole open, for two days, till the fermentation be abated. Then close it up or bottle it off, and it will be fit for being drunk in a few days afterwards. In North America, and perhaps in other countries, where the black and white spruce firs abound, instead of adding the essence of the spruce at the same time with the molasses, they make a decoction of the leaves and small branches of these trees, and find the liquor equally good. It is a powerful antiscorbutic, and may prove very useful in long sea-voyages.

SPUNGE. See SPONGIA.

SPUNGE, is also used, in gunnery, for a long staff or rammer with a piece of sheep or lamb-skin wound about its end, to serve for scouring great guns, when discharged, before they are charged with fresh powder.

SPUNGING, in gunnery, the cleaning a gun's inside with a sponge, in order to prevent any sparks of fire from remaining in her, which would endanger the life of him who should load her again.

SPUN *yarn*, among sailors, is a kind of line made from rope-yarn, and used for seizing or fastening things together.

SPUR, a piece of metal, consisting of two branches encompassing a horseman's heel, and a rowel in form of a star, advancing out behind, to prick the horse.

SPY, a person hired to watch the actions, motions, &c. of another; particularly of what passes in a camp. When a spy is discovered, he is hanged immediately.

SQUADRON, in military affairs, denotes a body of horse whose number of men is not fixed; but is usually from one to two hundred. Each squadron usually consists of three troops, of fifty men each.

In naval affairs a squadron either implies a detachment of ships employed on any particular expedition, or one-third part of a naval armament.

SQUALUS, the *shark*, in natural history, a genus of fishes of the order Cartilaginei. Generic character: mouth under the fore part of the head, with teeth disposed in rows, and partly moveable and partly fixed; generally five spiracles, at the sides of the neck, of a semilunar shape; body oblong, rather cylindric and rough, with tender prickles. These animals are never found in rivers or lakes, inhabiting only the sea, and carrying terror and destruction wherever they appear. They grow, in some species, to the weight of three or four thousand pounds. They occasionally emit a phosphoric illumination, visible by night. They produce their young alive, several at a birth, but every one inclosed in a transparent hornlike substance, lengthened at the extremity into a thread, which attaches to fixed substances, such as rocks or weeds. Some appear to live on vegetables chiefly, but the greater number are rapacious of animal substances in the extreme. They seize, indeed, whatever they find, with the most violent avidity, following in the wakes of ships, for the sake of nearly every thing thrown from them, and are fatal to those mariners who slip from their hold on the rigging into the sea, in which case the sharks are seen to tear them to pieces, with all the violence of competition. They are

in most instances solitary wanderers through the ocean, but in some species are gregarious. They contain large quantities of oil, and their skin is convertible to several useful purposes. There are thirty-four species. The following are the most entitled to attention. S. carcharios, or the white shark, attains sometimes the length of thirty feet, and is the most fierce and rapacious inhabitant of the ocean, in the depths of which, particularly in the warmer latitudes, it principally ranges. According to some writers, a man, and even a horse, has been found entire in the body of one of these animals; and the teeth of this, or some larger species, are exhibited in the British Museum, four inches and a half in depth. The intestines of this animal, generally, contain a vast number of tape worms, which may account, in some degree, for its peculiar voracity.

S. maximus, or the barking shark, is about the size of the former, and is often seen near the Hebrides in small shoals of six or eight, but generally in single pairs. These have nothing of the fierceness of the former species, and will suffer themselves to be handled without resistance. They subsist on sea-weeds, and their stomachs have never exhibited indications, on being opened, of any other substances. They often sport about the billows with great agility and appearance of delight, and will suffer a boat to approach them so nearly, that the harpooner may pierce them with the instrument in his hand. But it is stated that the wounds thus inflicted often excite at first no symptom of pain, and that in some cases no appearance of this is indicated, till the combined efforts of two men have urged the instrument to its fullest depth, when they exhibit extreme agitation and rapidity, traversing the water with the most turbulent movements, and summoning into exercise, for many hours, all the skill and energy of those engaged in this critical pursuit. See Pisces, Plate VI. fig. 1.

S. glaucus, or the blue shark, is the most elegantly shaped and coloured of all the species, is about ten feet long, and found in almost every sea. In the season for pilchards it abounds on the coasts of Cornwall, and is often taken with large iron hooks.

S. stellaris, or the greater spotted dog-fish, is a native of the seas of Europe. It seldom exceeds in length six feet. Its snout is considerably elongated, whence it derives its designation of the dog-fish. It is found chiefly in rocky situations, and preys upon various shell-fish. It produces nineteen at a birth, but does not appear extremely abundant. Its flesh is eaten, and its skin is an article of commerce.

S. zygæna, or the hammer-headed shark, is sixteen feet long, and inhabits the Mediterranean and Indian seas, where its depredations are incessant and most formidable. It is distinguished by its head being dilated on the sides to an extraordinary extent, and by the eyes being at the extremities of these sides.

S. squatina, or the angel fish, is distinguished by a large and flat head, rounded in front, is found in the European seas, and grows to the length of seven feet. It is highly fierce and formidable.

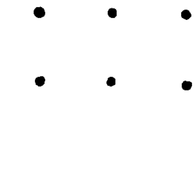
SQUALL, in naval language, is a sudden violent gust of wind usually occasioned by the interruption and reverberation of the wind from high mountains. Squalls are very frequent in the Mediterranean, particularly in the Levant, and are supposed to be produced by the new direction which the wind meets with in its passage between the various islands of the Archipelago.

SQUARE, in geometry, a quadrilateral figure, both equilateral and equiangular. To find the area of a square, seek the length of one side; multiply this by itself, and the product is the area of the square.

SQUARE *number*, the product of a number multiplied into itself. Thus 4, is the product of 2 multiplied by 2; or 16, the product of 4 multiplied by 4, are square numbers.

The series of square integers, is......1, 4, 9, 16, 25, 36, &c;
which are the squares of ....1, 2, 3, 4, 5, 6, &c.
Or the square fractions................$\frac{1}{4}$, $\frac{4}{9}$, $\frac{9}{16}$, $\frac{16}{25}$, $\frac{25}{36}$, $\frac{36}{49}$, &c.;
which are the squares of..............$\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{4}{5}$, $\frac{5}{6}$, $\frac{6}{7}$, &c.

A square number is so called, either because it denotes the area of a square, whose side is expressed by the root of the square number; as in the annexed square, which consists of nine little squares, the side being equal to three; or else, which is much the same thing, because the points in the number may be ranged in the form of a square, by making the root, or factor, the side of the square.



Some properties of squares are as follow:
1. Of the

Natural series of squares $1^2, 2^2, 3^2, 4^2$, &c.
which are equal to .....1 , 4 , 9 , 16 , &c.

The mean proportional mn between any two of these squares m^2 and n^2, is equal to the less square plus its root multiplied by the difference of the roots; or also equal to the greater square minus its root multiplied by the said difference of the roots. That is,

$$mn = m^2 + dm = n^2 - dn;$$

where $d = n - m$ is the difference of their roots.

2. An arithmetical mean between any two squares m^2 and n^2, exceeds their geometrical mean, by half the square of the difference of their roots.

That is $\frac{1}{2}m^2 + \frac{1}{2}n^2 = mn + \frac{1}{2}d^2$.

3. Of three equidistant squares in the series, the geometrical mean between the extremes, is less than the middle square by the square of their common distance in the series, or of the common difference of their roots.

That is, $mp = n^2 - d^2$;

where m, n, p, are in arithmetical progression, the common difference being d.

4. The difference between the two adjacent squares m^2 and n^2, is $n^2 - m^2 = 2m + 1$; in like manner, $p^2 - n^2 = 2n + 1$, the difference between the next two adjacent squares n^2 and p^2; and so on, for the next following squares. Hence the difference of these differences, or the second difference of the squares, is $2n - 2m = 2 \times \overline{n - m} = 2$ only, because $n - m = 1$; that is, the second differences of the squares are each the same constant number 2; therefore the first differences will be found by the continual addition of the number 2; and then the squares themselves will be found by the continual addition of the first difference; and thus the whole series of squares is constructed by addition only, as here below:

2d Diff......		2	2	2	2	2	2	&c.
1st Diff......	1	3	5	7	9	11	13	&c.
Squares......	1	4	9	16	25	36	49	&c.

5. Another curious property, also noted by the same author, is, that the sum of any number of the cubes of the natural series 1, 2, 3, 4, &c. taken from the beginning, always makes a square number, and that the series of squares, so formed, have for their roots the numbers...1, 3, 6, 10, 15, 21, &c. the diffs. of which are 1, 2, 3, 4, 5, 6, &c. viz.

$1^3 = 1^2$,
$1^3 + 2^3 = 3^2$,
$1^3 + 2^3 + 3^3 = 6^2$,
$1^3 + 2^3 + 3^3 + 4^3 = 10^2$; and in general
$1^3 + 2^3 + 3^3 + n^3 = (1 + 2 + 3 + n)^2 = \frac{1}{4}\,\overline{n.n+1}^2$; where n is the number of the terms or cubes.

Squaring the circle, is the making or finding a square whose area shall be equal to the area of a given circle. The best mathematicians have not yet been able to resolve this problem accurately, and perhaps never will. But they can easily come to any proposed degree of approximation whatever; for instance, so near as not to err so much in the area, as a grain of sand would cover, in a circle whose diameter is equal to that of the orbit of Saturn. The following proportion is near enough the truth for any real use, viz. as 1 is to .88622692, so is the diameter of any circle, to the side of the square of an equal area. Therefore, if the diameter of the circle be called d, and the side of the equal square s;

then is $s = .88622692d = \frac{39}{44}d$ nearly.

$$\text{and } d = \frac{s}{.88622692} = \frac{44}{39}s \text{ nearly.}$$

SQUARE *root*, a number considered as the root of a second power or square number; or a number, by whose multiplication into itself, a square number is generated.

SQUARE *battle*, or *Battalion of Men*, is one that hath an equal number of men in rank and file.

SQUARE, *hollow*, in the military art, is a body of foot drawn up with an empty space in the middle for the colours, drums, and baggage; faced and covered by the pikes every way, to keep off horse.

SQUARE, an instrument consisting of two rulers, or branches, fastened perpendicularly at one end of their extremes, so as to form a right angle; it is of great use in the description and mensuration of right angles, and laying down perpendiculars.

SQUARE, in naval affairs, is a term peculiarly appropriated to the yards and their sails, either implying that they are at right angles with the mast or keel, or that they are of greater extent than usual.

SQUIRREL. See SCIURUS.

STACHYS, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ, or Labiatæ. Essential character: corolla upper-lip arch-

ed; lower reflexed at the sides; the middle segments larger, emarginate; stamens finally reflexed towards the sides. There are twenty-four species.

STÆHELINA, in botany, so named from John Henry Stæhelin and his son, Swiss physicians, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Discoideæ. Cinarocephalæ, Jussieu. Essential character: anthers tailed; down branched; receptacle with very short chaffs. There are ten species.

STAFFA, an island situated on the coast of Scotland, three miles north-east of Iona, or Columb-kill, and west of Mull, about a mile in length, and half a mile in breadth, belonging to Mr. Lauchlin Mac Quarie. This inconsiderable isle is one amongst the most wonderful productions of nature, and deserves the attention of every natural philosopher, though it is unfortunately placed in a region which prevents frequent visits, even from curious investigators. The peculiarity that renders it so interesting, arises from the basaltes composing it, assuming a number of magnificent forms, equally astonishing and sublime; but as we purpose to describe them with some degree of minuteness, it will be proper to give a general sketch of the nature of the substance termed basaltes, and where it abounds, that the subject may be clearly understood. See BASALTES.

According to Strabo and Agricola, the antique basaltes is found in the same prismatical form in Egypt, which distinguishes its outline in various parts of Europe. Farber, a professor of natural history, at Mjetau, supposes that found in the Vicentine Paduan and Veronese districts of Italy, to be a chrystallized lava, and asserts that the antique basaltes is in every respect exactly similar to the compact lavas of Vesuvius and Monte Albano, which are used by statuaries to restore mutilated statues made of this material.

The Egyptian basaltes contain a small proportion in some of the varieties, of the white garnet like shorl crystallizations, and lamellas common in the Italian lavas, a circumstance that seems to prove to demonstration their volcanic production in these particular instances, though others of the oriental basaltes seem to have originated from aqueous mixtures.

Dr. Von Troil, member of the Academy of Sciences at Stockholm, entertained an opinion that they were caused by the operations of fire, which he founded on that of M. Desmaret's, who was the first naturalist that ventured to attribute them to that cause, in a description of some basalts found near St. Sandour, in Auvergne, presented by him to the attention of the French Academy of Sciences. Other naturalists who had considered them to be a species of chrystallization, ridiculed this idea as founded upon false principles, as they contended basalt pillars are discovered where it seemed highly improbable that volcanoes could ever have existed; still, however, they had the candour to enter into an examination of the assertion of M. Desmaret's, the result of which was nearly a confirmation of his conjecture, that basalt pillars were produced by subterraneous fires. As a collateral support of this hypothesis, Dr. Von Troil cites the instances of Stolpenstein in Meissen, Lauban in Lusatia, of Bohemia, Leignitz in Silesia, Brandau in Hessia, Sicily, Bolsenna, Montebello, and St. Forio in Italy; the district of Vicenza, Monte Rosso in the district of Padua, Monte Diavolo in the mountains of Verona, in Lower Languedoc, in Ireland, and in the western islands of Scotland, in each of which places he says a doubt cannot be entertained that volcanoes have existed; besides those he mentions St. Giovanni, Monte Castillo, Monte Nuovo, Monte Oliveta, near Cader Idris in Wales, and almost every part of Velay and Auvergne, where the towns of Chillac and St. Fluor are situated upon basaltes.

The peasantry of Iceland seem to have entertained a similar opinion of their origin to that of the lower orders of the Irish, as the former suppose them to have been piled in the regular manner, they are seen there, by giants, and thence call them Trollahland and Trollkonugardur, and the latter term their magnificent causeway, the Giants. The pillars of the Icelandic basaltes have generally from three to seven sides, they vary in thickness from four to six feet, and some are of thirty-six, and others even forty-eight feet in length, without horizontal divisions; but such is the capricious operations of nature, that pillars are sometimes found not more than six or twelve inches long; those, however, are invariably very regular, and are made use of for doors and windows; at others they appear in the utmost confusion, broken, and overturned; in particular instances they just appear above the surface of the mountains, amongst lava and tufa, and there are places where they ex-

tend three miles together without interruption. The basalt pillars of Glockenberg in Snefialdsnas, exhibit a very different appearance from those of any other part of Iceland, as the pillars on the summit of that mountain lie horizontally, those on the sides incline, and the lowest stand erect. In some places they are found as if bent, when heated, into a semicircular form, an effect which seems to confirm the idea that violent fires have prevailed either at their formation or subsequently.

The substance of the pillars of this island, resemble those of Staffa in some parts of it, but in others they are more porous, and incline more to a grey colour. This circumstance induced the Doctor to think it would be an easy matter to trace all the gradations between the most perfect basalt pillar and the coarsest description of lava, and he even saw some at Videy of a fine grain, extremely solid, of a blackish grey, and consisting of many joints; some porous glassy kind of stone, which he found at Laugarnas, near the sea, was so indistinctly divided, that he was undecided whether to class it with the lavas or basalt pillars; but the opinion of his friends determined him in favour of the latter.

We have been the more particular in noticing the peculiarities of the basaltes of Iceland, as that island is situated in the vicinity of Staffa, to which we shall now turn our attention. The gentleman we have just mentioned was one of the first persons who had the good fortune to examine the latter with any degree of accuracy, nor indeed had the public been informed before of the distinguishing marks which render it so highly interesting. Buchanan being then the only author that had noticed this beautiful work of nature, though very slightly. Mr. Pennant, who possessed every requisite talent for informing the world, was disappointed by an adverse wind, from visiting Staffa in the year that proved more favourable to Dr. Von Troil, who would have been exactly in the same situation in all probability, had not the tide, which flows with great strength between the western isles of Scotland, compelled the captain of the vessel employed to take him to Iceland, to anchor, on the night of the twelfth of August, in the sound between the Isle of Mull and Morvern on the continent, and precisely opposite to Drumnen, the seat of Mr. Maclean, by whom the Doctor and his friends were immediately invited on shore to breakfast, with the characteristic hospitality of the Highlanders. Mr. Banks, now Sir Joseph, being of the party intending to visit Iceland, eagerly accepted, with the Doctor, and others, the offer of Mr. Maclean to conduct them to Staffa, to which they were conveyed by the ship's long boat the same evening, about nine o'clock. "It was impossible," says the Doctor, "for our surprise to be increased, or our curiosity to be fuller gratified, than they were the next morning, when we beheld the no less than beautiful spectacle which nature presented to our view. If we even with admiration behold art, according to the rules prescribed to it, observing a certain kind of order, which not only strikes the eye, but also pleases it, what must be the effect produced upon us when we behold nature displaying, as it were, a regularity which far surpasses every thing art ever produced. An attentive spectator will find as much occasion for wonder and astonishment, when he observes how infinitely short human wisdom appears, when we attempt to imitate nature in this as well as in any other of her grand and awful productions, and though we acknowledge nature to be the mistress of all the arts, and ascribe a greater degree of perfection to them, the nearer they approach and imitate it, yet we sometimes imagine that she might be improved, according to the rules of architecture. How magnificent are the remains which we have of the porticos of the ancients, and with what admiration do we behold the colonnades that adorn the principal buildings of our times, and yet every one who compares them with Fingal's cave, formed by nature in the Isle of Staffa, must readily acknowledge that this piece of nature's architecture far surpasses every thing that invention, luxury, and taste ever produced among the Greeks."

A small cave on the west side of the island affords a convenient landing place, but there are no regular basalt pillars to be met with in its immediate vicinity. On the south side of it are some narrow pillars, which are inclined, and resemble the springs of the ribs of an arch, beyond those is a small grotto, on the right hand, not composed of pillars, though they appear above it disposed in the manner of the interior parts of the timbers of a *ship*. At a few yards distance, and opposite to the grotto, extends the peninsula of Bo-sha-la, consisting of regular, but smaller pillars, which are all of a conical figure. Some of these diverge as from a centre, some incline,

and others, and by far the greater number, are perpendicular. The island itself, opposite to Bo-scha-la, is composed of thick columns which extend into the sea as far as the eye is able to penetrate, but are not very high, and gradually decrease as they approach the water. Their relative connection is so admirably preserved, that a person may walk upon their ends as conveniently as if ascending or descending the steps of a stair-case; these lead to Fingal's, or Finhn Mac Coul's cave or grotto, which is excavated out of that mountain from north-east to east.

The cave is formed by regular pillars, extending to a great distance on each side, which support an arch composed of the obtuse points of others, placed very close together; unfortunately the floor of this wonderful place is covered by a body of clear fresh water, several feet in depth, through which may be seen an incredible number of fragments of pillars. The colour of the columns is grey, inclining to black, and the joints are distinguishable by the intervention of a yellow stalactic quarry rind, that exhales, and serves to make the separations more distinct, at the same time that it produces an agreeable effect by many different gradations of colour.

A sufficient degree of light enters the cave to illuminate it to the extremity, where the ranges of pillars are perfectly discernible, and the ebbing and flowing of the tide constantly conveying and discharging air from within it, is at all times fit for respiration, and by no means noxious. This circumstance may still further originate from the passage of the water through a fissure in the rocks, rather lower than the surface, which occasions a rushing sound upon each rise of the tide, that contributes to render the effect of the whole still more singular and impressive. A boat is certainly the most convenient for visiting Fingal's cave, but it is possible to walk into it upon the points of some of the pillars which are higher than the level of the water.

The party already mentioned measured the dimensions of this beautiful grotto, and we acknowledge ourselves indebted to Dr. Von Troil for the following particulars:

	Ft.	In.
The length from the furthest of the basalt pillars, which from the shore formed a canal to the cave, 121 ft. 6 in.; from the commencement of the vault to the end of the cave, 250 ft.	371	6
The breadth of its entrance	53	7
Of the interior end	20	0
The height of the vault at the entrance of the cave	117	6
Of ditto at the interior end	70	0
The height of the outermost pillar in one corner	39	6
The height of another in the north-west corner	54	0
The depth of the water at entrance	18	0
Of the inside end	9	0
From the water to the foot of the pillars	36	8
Height of the pillars	32	6
Height of the arch, or vault, above the top of the pillars	31	4
The stratum above	34	4

The western corner of Fingal's cave.

From the water to the foot of the pillars	12	10
Height of the pillars	37	3
The stratum above them	66	9
Further west—the stratum beneath the pillars	11	0
Height of the pillars	54	0
The stratum above	61	6
Still more westward—stratum beneath the pillars	17	1
Height of the pillars	50	0
The stratum above them	51	0
More west—stratum beneath the pillars	19	8
Height of the pillars	55	1
The stratum above	54	7

The stratum beneath the pillars was considered by the party to be no other than tufa, which being heated at the period when this phenomenon was produced, received into its depths fragments of basalt, that above them tinged with red, appears to be lava, containing other fragments scattered in various unequal directions, although it is evident that the most violent heat must have acted upon it, yet there are not the least traces in its exterior, the pillars having been removed by it, for the whole enormous mass rests upon them.

On the north side of the island is another cave, called Corvoranti, where the stratum is raised, and the pillars consequently appear shortened; those are tolerably distinct, and continue so till the intervention of a bay, that extends some distance inland, and there the pillars are discontinued. The mountains in this neighbourhood are composed of dark brown stone, which may or may not be lava; but there is no sort of

regularity observable in its texture. On passing further, and on the south-east side of the island, the basalt columnar appearance commences, though almost imperceptibly; hence they gradually assume their characteristic form, till at last the spectator finds himself on the spot where they are in full perfection.

The shape of the columns vary from three to seven sides, though the majority have five and six; the former are so numerous, that a heptagonal pillar is surrounded with seven others, which join closely to its seven sides. In some instances inconsiderable fissures may be perceived, but those are generally filled with quartz, and in one particular place that had penetrated through several pillars without interrupting, the regularity of their arrangement, one of the greatest wonders attending this operation of nature, is the separation of each pillar into pieces, which are so closely jointed, that it is almost impossible to introduce a knife between the interstices. Upon an attentive examination of many of those pieces, it was found that the uppermost was generally concave, in some cases flat, but very rarely convex. When the upper surface was flat, the lowest joint was the same; but when it was excavated, the lower one was rounded and reversed.

The sides of the pillars are of unequal dimensions, to prove which we shall give the measurement of two, extracted from the Letters on Iceland, containing Dr. Von Troil's communication on this subject.

One with four sides.

	Ft.	In.
First side	1	5
Second	1	1
Third	1	6
Fourth	1	1

With seven sides.

	Ft.	In.
First side	2	10
Second	2	4
Third	1	10
Fourth	2	0
Fifth	1	1
Sixth	1	6
Seventh	1	3

The angles are as sharp and well defined as those of the pillars of the Giant's Causeway in Ireland, and their colour is generally black, the inclination to yellow being confined to the external sides, which are exposed to, and in some degree bleached by the action of the sun, rain, and wind. The texture of their substance much resembles, and is probably the same as the Icelandic agate. Professor Bergman was divided in opinion, whether these pillars were produced by fire acting upon particular substances, or whether subterraneous fires, sending forth vapour, may have softened the superincumbent earth, which becoming soft, and yielding to the force below, ascended in this peculiar form, and became gradually petrified. This latter supposition met the ideas of Von Troil, who illustrates it by saying, he has observed the distinct and regular appearance alluded to in dried clay, and even starch, when dried in a bason. "For," adds the latter, "it may be demonstrated that they are not crystals formed by nature, by their not being produced as all other crystals are, by external apposition (per appositionem), nor in any other matrix, as is common among crystals." He further observes, "The following may, however, serve as a proof that I did not, without due foundation, believe them to be a kind of lava, which burst in growing cold and hard. First, you find both in the Island of Staffa, and many other places, that the pillars stand on lava or tufa, and are surrounded by this matter. Secondly, at Staffa there was a large stratum above the pillars, in which there were many pieces of those pillars irregularly thrown one among another, which leaves us to conjecture that they must have been more in number, and higher, after an old eruption of fire; but that a subsequent eruption had overthrown them and mixed them with the whole mass."

STAIR-CASE, in architecture, an ascent inclosed between walls, or a balustrade, consisting of stairs, or steps, with landing-places and rails, serving to make a communication between the several stories of a house. The construction of a complete stair-case is one of the most curious works in architecture.

STAKE, the name of a small anvil, used by smiths; sometimes it stands on a broad iron foot on the work-bench, to be moved up and down occasionally; and sometimes it hath a strong iron spike at the bottom, by which it is fixed to some place on the work-bench. Its use is to set small and cold work straight, by hammering it on the stake; or to cut or punch upon the cold chissel or cold punch.

STALACTITÆ, *stony icicles*, in natural history, crystalline spars formed into ob-

long, conical, round, or irregular bodies, composed of various crusts, and usually found hanging in form of icicles from the roofs of grottos, &c. Of this class there are various species, as the hard, white stalactitæ; the white, shattery stalactitæ, and the yellow, shattery, crystalline stalactitæ, &c.

STALK, in botany, that part of a plant which rises immediately from the root, and which supports the leaves of the flowers, and the fruit. See BOTANY.

STAMINA, in botany, *threads*, which, in most flowers, are placed round the seed-bud: they are designed for preparing the pollen, which is the chief agent in the generation of plants. The stamen is divided into the "filamentum," or slender, thread shaped part, resembling a foot-stalk, the "anthera," and the "pollen."

STAMINA, in the animal body, are defined to be those simple original parts, which existed first in the embryo, or even in the seed, and by whose distinction, augmentation, and accretion, by additional juices, the animal body, at its utmost bulk, is supposed to be formed.

STANCHION, or *stanchions*, in a ship, those pillars which, being set up pillar-wise, do support and strengthen the waste-trees.

STAND in commerce, a weight, from two hundred and a half to three hundred, of pitch.

STANDARD, in war, a sort of banner, or flag, borne as a signal for the joining together of the several troops belonging to the same body. The standard is usually a piece of silk, a foot and a half square, on which are embroidered the arms, device, or cipher of the prince, or of the colonel. it is fixed on a lance, eight or nine feet long, and is carried in the centre of the first rank of a squadron of horse. The standard is used for any martial ensign of horse, but more particularly for that of the general, or the royal standard: those borne by the foot are rather called colours.

The royal standard is a flag in which the imperial ensigns of England, Scotland, and Ireland, are quartered, together with the armorial bearings of Hanover. It is never hoisted, unless when the King is on board, then it is displayed at the main-top gallant-mast-head.

STANDARD, in commerce, the original of a weight, measure, or coin, committed to the keeping of a magistrate, or deposited in some public place, to regulate, adjust, and try the weights used by particular persons in traffic. The justness of weights and measures is of that importance to the security and good order of trade, that there is no civilized nation, but makes it a part of their policy, to preserve the equality thereof by means of standards. The standards of weights and measures in England, are appointed, by magna charta, to be kept in the Exchequer, by a special officer, called the clerk or comptroller of the market.

The standard of gold coin is twenty-two carats of fine gold, and two carats of alloy, in the pound weight troy: and the French, Spanish, and Flemish gold are nearly of the same fineness. The pound weight is cut into forty-four parts and a half, each current for twenty-one shillings. The standard of silver is eleven ounces and two pennyweights of silver, and eighteen pennyweights of alloy of copper. Whether gold or silver be above or below standard, is found by assaying, and the hydrostatical balance. See the articles ASSAYING and HYDROSTATICS.

STANDING, in the sea-language. Standing part of the sheet, is that part of it which is made fast to a ring at the ship's quarter. Standing part of a tackle, is the end of the rope where the block is fastened. Standing ropes are those which do not run in any block, but are set taught, or let slack, as occasion serves, as the sheet-stays, back-stays, or the like.

STANNARIES, the mines and works where tin is dug and purified, as in Cornwall, Devonshire, &c. There are four courts of the stannaries in Devonshire, and as many in Cornwall, and great liberties were granted them by several acts of parliament, in the time of Edward I. &c. though somewhat abridged under Edw. III. and Charles I.

STANNUM. See TIN.

STAPELIA, in botany, so named in memory of Bodeus à Stapel, a physician of Amsterdam, a genus of the Pentandria Digynia class and order. Natural order of Contortæ. Apocineæ, Jussieu. Essential character: contorted, nectary a double little star covering the gentials. There are forty-nine species.

STAPHYLEA, in botany, a genus of the Pentandria Trigynia class and order. Natural order of Trihilatæ. Rhamni, Jussieu. Essential character: calyx five-parted, petals five, capsule inflated, connate; seeds two, globular, with a wart. There are three species.

STAPHYLINUS, in natural history, a genus of insects of the order Coleoptera

antennæ moniliform, feelers four, shells half as long as the body, wings folded up under the shells, tail not armed with a forceps, furnished with two exertile vesicles. There are nearly two hundred species, in three sections. A. All the feelers filiform. B. Hind feelers hatchet shaped, fore feelers clavate. The wings of the insects of this genus are curiously pleated or convoluted beneath the short and abruptly terminated wing sheaths. The most remarkable, as well as the largest of the British species, is the S. major, which is more than an inch long, entirely of a deep colour, and when disturbed sets up the hinder part of its body, as if in a posture of defence; it is very frequently seen, during the autumnal season, about sunny pathways, fields, and gardens, and is furnished with a large head, and very strong forcipated jaws. The insects of this whole tribe are extremely rapacious, devouring whatever insects they can catch, and frequently each other: many of them, when attempted to be caught, turn up the tail: the jaws are strong and exserted, with which they bite and pinch very hard. Most of them are found in damp places, among putrid substances, and a few upon flowers.

STAPLE primarily signifies a public place or market, whither merchants, &c. are obliged to bring their goods to be bought by the people, as the Greve, or the places along the Seine, for sale of wines and corn, at Paris, whither the merchants of other parts are obliged to bring those commodities. Formerly the merchants of England were obliged to carry their wool, cloth, lead, and other like staple commodities of this realm, in order to utter the same by wholesale; and these staples were appointed to be constantly kept at York, Lincoln, Newcastle upon Tyne, Norwich, Westminster, Canterbury, Chichester, Winchester, Exeter, and Bristol; in each whereof a public mart was appointed to be kept, and each of them had a court of the mayor of the staple, for deciding differences, held according to the law-merchant, in a summary way. The staple-commodities of this kingdom are said by some to be these, viz. wool, leather, wool fells, lead, tin, butter, cheese, cloth, &c. but others allow only the first five to be staple commodities.

STAR, in astronomy, a general name for all the heavenly bodies, which, are dispersed throughout the whole heavens.

The stars are distinguished, from the phænomena of their motion, &c. into fixed, and erratic or wandering stars: these last are again distinguished into the greater luminaries, viz. the Sun and Moon, the planets, and the comets, each whereof has been fully considered and explained under their respective articles. SUN, MOON, &c.

As to the fixed stars, or simple stars, they are so called because they seem to be fixed, or perfectly at rest, and consequently appear always at the same distance from each other.

An observer will first divide these stars into several classes according to the splendor of their light, the brightest he will call stars of the first magnitude, those of the next inferior light, he will call stars of the second magnitude, and so in order to those which can barely be seen by the naked eye, which are called stars of the sixth magnitude: and those which cannot be seen but by the help of magnifying glasses, are of the seventh, eighth, &c. magnitudes. Afterwards, to avoid confusion, and to be able to point out any one star, without being obliged to give a particular name to each, he will divide them into separate parcels, of which he will make a particular plan; and to each of these constellations, or parcels of stars, he will assign a figure at pleasure, as that of a Ram, a Bull, a Dragon, a Hercules, &c. but so that all the stars in each of the parcels, drawn in the plan, may be enclosed in the designed figures, and correspond to the different parts from whence they take their name: for example, having drawn the figure of a bull about a parcel, or constellation, of stars, that star which falls in the eye will be called the star in the Bull's Eye, or simply, the Bull's Eye, another, which respects the tip of one horn, will be named the Bull's Horn and so of others. A parcel of stars thus contained in any assigned figure, is called a constellation. By this means, notwithstanding the seeming impossibility of numbering the fixed stars, their relative situations one to another have been so carefully observed by astronomers, that they have not only been able to number them, but even to distinguish the place of each star in the heavens, and that with greater accuracy than any geographer could ever point out the situations of the several cities or towns upon the surface of the earth, and not only the places of those few, if they may be so called, which are to be seen with the naked eye, have been pointed out and registered by them, but even of those which are discovered only by the telescope. The most

ancient observations of the stars, which have reached these times, were made by Timocharis and Aristillus, about 300 years before Christ. The next after them, who made a catalogue of the stars visible to the naked eye, and registered their places, was Hipparchus of Rhodes; he flourished about 120 years before Christ, and numbered 1022 stars. After him, Ptolemy enlarged his catalogue to 1026: Ulug Beigh, the grandfather of Tamerlane the Great, about the year 1437, constructed a new catalogue, more exact than that of Ptolemy, containing 1017 stars: Tycho, in the year 1600, determined the places of 777 fixed stars, and reduced them to a catalogue: Kepler's catalogue contained 1163 stars; and that of the Prince of Hesse, 400: Ricciolus enlarged Kepler's catalogue to 1468; and John Bayer, a German, had described the places of 1725 stars: after this, about 1670, Hevelius of Dantzic, composed a catalogue of 1888 fixed stars: Dr. Halley also undertook a voyage to the island of St. Helena, in order to take the position of the stars within the antarctic circle, of which he published a catalogue, containing 373 stars: but the largest and most complete catalogue ever yet published, is that of our accurate astronomer Mr. Flamsteed, in his Celestial History, which contains nearly 3000 stars; all whose places are more exactly determined in the heavens, than the position of cities and other places on the earth.

We ought not, however, to imagine, that all the fixed stars are thus numbered, and reduced to their respective places in the heavens; since their number continually increases, according to the goodness of the telescope, appearing millions beyond millions, till, by their immense distance, they evade the sight, even though assisted by the best instruments. The telescopical stars with which Mr. Flamsteed has enriched his catalogue, are only the more remarkable ones, whose longitudes and latitudes, or situations in the heavens, it was thought worth while to register and put down. Dr. Hook, with a telescope of twelve feet, saw 78 stars among the Pleiades; and with a longer telescope, still more: and, in the single constellation of Orion, which in Mr. Flamsteed's catalogue, has but 80 stars, there have been seen 2000. We may, therefore, venture to pronounce the number of fixed stars, including the telescopic ones as well as those visible to the naked eye, to be infinitely great, far beyond what it is possible for the best astronomers to calculate, much less to reduce to order. But though the stars are certainly innumerable, yet those visible to the naked eye, in one hemisphere, seldom exceed a thousand; which, perhaps, may appear strange, since, at first sight, their number seems immensely great: but this is only a deception of sight, arising from a confused and transient view; for let a person single out a small portion of the heavens, and after some attention to the situation of the more remarkable stars therein, begin to count, he will soon be surprised to find how few there are therein. However, even the number of stars visible to the naked eye, small as it is in comparison with that of the telescopic ones, is far from being constant; since, besides that the different states of the atmosphere render many of the lesser stars invisible, some stars have been observed to appear and disappear by turns; particularly one in the chair Cassiopeia, in the year 1572, which, for some time, outshone the biggest of the fixed stars, and in sixteen months time, by degrees, vanished quite away, and was never seen since: in the year 1640, the scholars of Kepler saw a star in the right leg of Serpentarius, which likewise gradually disappeared: Fabricius, in the year 1596, gives the first account of the stella mira, or wonderful star, in the neck of the Whale; which has been since found to appear and disappear periodically, its period being seven revolutions in six years, but is never quite extinguished. Several other new stars have been observed: as one by Hevelius, in 1670, and another by Mr. Kircher, in 1639. These new stars are generally observed in the galaxy, or milky way, see Galaxy.

As to the causes of this appearing and disappearing of the fixed stars, Sir Isaac Newton conjectures, that as it is possible our Sun may sometimes receive an addition of fuel by the falling of a comet into it; so the sudden appearance of some stars, which formerly were not visible to us, may be owing to the falling of a comet upon them, and occasioning an uncommon blaze and splendour for some time: but that such as appear and disappear periodically, and increase by very slow degrees, seldom exceeding the stars of the third magnitude, may be such as having large portions of their surfaces obscured by spots, may, by revolving round their axis, like the Sun, expose their lighter and darker parts to us successively.

Nature and Distance of the fixed Stars. From the similitude there appears to be between them and the Sun, it is generally supposed by philosophers, that they are not placed in the heavens by way of ornament only, or to supply us with a faint light in the absence of the Moon; but that each of them is placed in the midst of a system of planetary worlds, and that it directs their motions, and supplies them with light and heat, in the same manner that the Sun does the several bodies of which our solar system is composed; in short, that they are so many suns, which no doubt have planets moving regularly round them, though invisible to us. That this is not mere hypothesis, will appear from the following arguments, drawn from the analogy they bear to our Sun: the Sun shines by its own native light, and so do the fixed stars: the Sun, at the distance of the fixed stars, would appear no larger than a star; none of our planets, at that distance, could be seen at all: is it not probable, therefore, that each of the fixed stars is a fixed sun, surrounded by a system of planets and comets, which may be again furnished with different numbers of satellites, or moons, though invisible to us? Besides, as the number of stars is immensely great, dispersed through spaces of the universe, far beyond the reach of the best telescopes, and as God has made nothing in vain, it seems highly probable that they severally serve the purposes of light and heat for the planets of their systems; since nothing can be more absurd than to pretend that myriads of unseen stars were made to twinkle in the unknown regions of the universe.

That the fixed stars shine by their own light, is thus proved: when viewed through a telescope, they appear only as mere lucid points, destitute of all sensible magnitude, and consequently must be at a vast distance; because the satellites of Jupiter and Saturn, when viewed through a telescope, appear of very distinguishable magnitudes, and yet are invisible to the naked eye. Since, then, the fixed stars are at such a vast distance, that the best telescope has no power to magnify them, and nevertheless shine with a very bright and sparkling light, it is inferred that they must shine with their own proper and unborrowed light; because, if their light was only borrowed, they would, like the satellites already mentioned, be invisible to the naked eye.

The celebrated Huygens found the brightest and largest, and consequently the nearest of the fixed stars, *viz.* Sirius, or the Dog-star, to be in appearance 27,664 times less than the Sun; and since the distances of objects are greater as their apparent magnitudes are lesser, the Dog-star must be distant from our Earth 2,000,000,000,000, or above two millions of millions of English miles; which is so very great, that a cannon-ball continuing in the same velocity it acquires when immediately discharged at the mouth of the cannon, would spend almost seven hundred thousand years in passing through it: and it is very probable, that the fixed stars are equally distant from each other, as the nearest of them is from our Sun; since, the better the telescopes we make use of, the more stars are seen. Hence it is very natural to conclude, that all the fixed stars are not placed at equal distances from us: but that they are every where interspersed, at great distances beyond one another, throughout the universe; and that, probably, the different appearances which they make, in point of splendour and magnitude, may be rather owing to their various distances from us, than to any real difference in their magnitudes.

From what has been said, concerning the number, nature, and distance of the fixed stars, the hypothesis of a plurality of worlds, wherein each fixed star serves as a sun to a system of planets, seems rational, worthy a philosopher, and greatly displays the wisdom, and redounds to the glory of the great Creator and Governor of the universe. Under the article Sun will be mentioned some of the speculations of Dr. Herschel.

Star, in heraldry, a charge frequently borne on the shield, and the honourable ordinaries, in figure of a star.

Star is also a badge of honour, worn by the Knights of the Garter, Bath, and Thistle. See Garter.

Star, in pyrotechny, a composition of combustible matters, which, being thrown aloft in the air, exhibits the appearance of a real star. Stars are chiefly used as appendages to rockets, a number of them being usually inclosed in a conical cap or cover, at the head of the rocket, and carried up with it to its utmost altitude, where the stars, taking fire, are spread around, and exhibit an agreeable spectacle.

Star-*board* denotes the right hand side of a ship, when a person on board stands with the face looking forward towards the head or fore part of the ship. In contra-

distinction from larboard, which denotes the left hand side of the ship in the same circumstances. They say, "Starboard the helm," or "Helm a starboard," when the man at the helm should put the helm to the right hand side of the ship.

Star *falling* or *shooting Star*, a luminous meteor darting rapidly through the air, and resembling a star falling. The explication of this phenomenon has puzzled all philosophers, till the modern discoveries in electricity have led to the most probable account of it. Signior Beccaria makes it pretty evident that it is an electrical appearance, and recites the following fact in proof of it. About an hour after sunset, he and some friends that were with him observed a falling star directing its course towards them, and apparently growing larger and larger, but it disappeared not far from them; when it left their faces, hands, and clothes, with the earth, and all the neighbouring objects, suddenly illuminated with a diffused and lambent light, not attended with any noise at all. During their surprise at this appearance, a servant informed them that he had seen a light shine suddenly in the garden, and especially upon the streams which he was throwing to water it. All these appearances were evidently electrical; and Beccaria was confirmed in his conjecture, that electricity was the cause of them, by the quantity of electric matter which he had seen gradually advancing towards his kite, which had very much the appearance of a falling star. Sometimes also he saw a kind of glory round the kite, which followed it when it changed its place, but left some light, for a small space of time, in the place it had quitted.

Star-chamber was a very ancient court, but new modelled afterwards by divers statutes. It consisted of several of the lords spiritual and temporal, being privy counsellors, together with two judges of the courts of common law, without the intervention of any jury. The legal jurisdiction extended over riots, perjury, misbehaviour of public officers, and other notorious misdemeanors. But afterwards, they stretched their power beyond the utmost bounds of legality, vindicating all the encroachments of the crown in granting monopolies, in issuing proclamations which should have the force of laws, in punishing small offences, or no offences at all, but of their own creating, by exorbitant fines, imprisonment, and corporal severities; until at last this court became so odious, that it was finally abolished by the 16 Charles I. c. 10. Most of the ancient authorities respecting the law of libels come from this court.

Star *Fish*. See Asterias.

STARCH. This term is appropriated to a substance existing in vegetables, similar in many of its properties to gum. It is a dry, white powder, which forms the principal part of the nutritive grains and roots. If a paste be formed of wheaten flour and water, and this be washed with additional quantities of water, till it is no longer turbid, but comes off pure and colourless, the mass which remains becomes tenacious and ductile. This is called Gluten, which see. If the water with which the paste was washed be allowed to remain at rest, it deposits a white powder, which is distinguished by the name of fecula or starch. Starch is of a fine white colour, and is usually in the state of concrete columnar masses. It has no perceptible smell, and scarcely any taste. It is little altered by exposure to the air; when it is exposed to heat, on a hot iron, it melts, swells up, becomes black, and burns with a bright flame. The charcoal which remains contains a little potash. When it is distilled, it gives out water mixed with acetic acid, which is contaminated with oil. It gives out also carbonic acid, and carbonated hydrogen gas. Starch is not soluble in cold, but forms a thick paste with boiling water; and when this paste is allowed to cool, it becomes semi-transparent and gelatinous; it is brittle when dry, somewhat resembling gum. If this paste be exposed to moist air, it is decomposed, for it acquires an acid taste. Sulphuric acid dissolves starch slowly; sulphurous acid is disengaged, and a great quantity of charcoal is formed. Muriatic acid also dissolves starch, and the solution resembles mucilage of gum Arabic. When left at rest, a thick, oily, mucilaginous liquid appears above, and a transparent straw-coloured fluid below. The odour of muriatic acid remains, but when water is added, it is destroyed, and a strong peculiar smell is emitted. Starch is also soluble in nitric acid, with the evolution of nitrous gas. The solution assumes a green colour, and when heat is applied, the starch is converted into oxalic and malic acids. Some part of the starch, however, is insoluble in nitric acid, and, when this is separated by filtration, and washed with water, it has a thick, oily appearance like tallow, is soluble in alcohol, and when distilled, yields acetic acid, and an oily matter similar to tallow in

odour and consistence. Starch is insoluble in alcohol, but is soluble in the alkalies; in pure potash it swells up, becomes transparent and gelatinous, and is then susceptible of solution in alcohol. The component parts of starch, as appears by distilling it, and by the action of re-agents, are oxygen, hydrogen, and carbon. Starch exists in a great number of vegetable substances, but chiefly in the roots and seeds, and particularly those which are employed as food. Starch, it is well known, may be obtained from the potatoe. If the potatoe be grated down, and washed with water till it comes off pure and colourless, this water, being left at rest, deposits a fine white powder, which assumes something of a crystallized appearance, and is heavier than wheat starch. It is generally mixed or combined with other principles, and sometimes so intimately as not easily to be separated. It is not completely formed, except in certain states of vegetation. In nutritive grains it is perfect only when they have attained maturity, before this it is in a state approaching to mucilage, mixed with saccharine matter.

STARLING. See STURNUS.

STATICE, in botany, *thrift*, a genus of the Pentandria Pentagynia class and order. Natural order of Aggregatæ. Plumbagines, Jussieu. Essential character: calyx one-petalled, entire, plaited, scariose; petals five; seed one, superior. There are thirty-nine species.

STATICS, a term which the modern improvements in knowledge have made it necessary to introduce into physico mathematical science. It was found convenient to distribute the doctrines of universal mechanics into two classes, which required both a different mode of consideration, and different principles of reasoning. We are indebted to Archimedes for the fundamental principles of this science. He investigated the doctrine of the centre of gravity, and the theory of the lever. But the subject of moving forces was not properly understood till Galileo considered it very accurately in his work on "Local Motion." In this, he considers a change of motion, as the exact and adequate measure of a moving force; and he considers every kind of pressure as competent to the production of such changes. He applied this principle to the motion of bodies by the action of gravity, and gave the theory of projectiles. Sir Isaac Newton took up the subject nearly as Galileo had left it, and applied the doctrines, which had been previously called in aid of mechanics only, to explain the celestial motions, and the magnificence of this subject caused it to occupy the whole attention of mathematicians. The "Principia" contained, indeed, propositions equally conducive to the improvement of common mechanics, and to the complete understanding of the mechanical actions of bodies. Philosophers began to make their applications. They saw that every kind of work that is performed by a machine, may be considered abstractedly as a retarding force; that the impulse of water, or wind, which are employed as moving powers, act by means of pressures which they exert on the impelled point of the machine; and, that the machine itself may be considered as an assemblage of bodies, moveable in certain limited circumstances, with determined directions and proportions of velocity. From these considerations resulted a general abstract condition of a body acted upon by known powers: at length was determined a new kind of equilibrium, not thought of by ancient mechanicians, between the resistance to the machine performing work, and the moving power, which exactly balance each other, and is indicated not by the rest, but by the uniform motion of the machine. Hence also the mathematician was enabled to calculate the precise motion of water which would completely absorb, or balance, the superiority of pressure by which water is forced through a sluice, pipe, &c. with a constant velocity.

Thus the general doctrines of motion came to be considered in two points of view, according as they balanced each other in a state of rest, or of uniform motion. These two ways of considering the same subject, required both different principles and a different manner of reasoning. The first has been named statics, as expressing that rest which is the test of this kind of equilibrium. The second has been called dynamics, or universal mechanics, because the different kinds of motion are characteristic of the powers or forces which produce them. A knowledge of both is indispensably necessary for acquiring any useful, practical knowledge of machines: and it was ignorance of the doctrines of accelerated and retarded motions, which made the progress of practical mechanical knowledge so very slow and imperfect. The mechanics, even of the moderns, before Galileo, went no further than to state the proportion of the power and resistance which

would be balanced by the intervention of a given machine, or the proportion of the parts of a machine, by which two known forces may balance each other. This view of the matter introduced a principle, which even Galileo considered as a mechanical axiom, *viz.* that what is gained in force, by means of a machine, is exactly compensated by the additional time which it obliges us to employ. This is not quite accurate, and not only prevents improvement in the construction of machines, but leads to erroneous maxims of construction. The two principles of dynamics teach us, that there is a certain proportion of the machine dependent on the kind and proportion of the power and resistance, which enables the machine to perform the greatest possible work. It is highly proper, therefore, to keep separate these two ways of considering machines, that both may be improved to the utmost, and then to blend them together in every practical discussion. Statics, therefore, is preparatory to the proper study of mechanics; but it does not hence derive all its importance. It is the sole foundation of many useful parts of knowledge. This will be best seen by a brief enumeration. 1. It comprehends all the doctrines of the excitement and propagation of pressure, through the parts of solid bodies, by which the energies of machines are produced. A pressure is exerted on the impelled point of a machine, such as the float-boards or buckets of a mill-wheel. This excites a pressure at the pivots of its axle, which act on the points of support. This must be understood, both as to direction and intensity, that it may be effectually resisted. A pressure is also excited at the acting tooth of the cog-wheel, on the same axle, by which it urges round another wheel, exerting similar pressures on its pivots, and on the acting tooth, perhaps, of a third wheel. Thus a pressure is ultimately excited in the working point of the machine, perhaps a wiper, which lifts a heavy stamper, to let it fall again on some matter to be pounded. Now statics teaches us the intensities and direction of all those pressures, and therefore how much remains at the working point of the machine unbalanced by resistance. 2. It comprehends every circumstance which influences the stability of heavy bodies; the investigation and properties of the centre of gravity; the theory of the construction of arches, vaults, and domes; the attitudes of animals. 3. The strength of materials, and the principles of construction, so as to make the proper adjustment of strength and strain, in every part of a machine, edifice, or structure of any kind. Statics, therefore, furnishes us with what may be called a theory of carpentry, and gives us proper instructions for framing floors, roofs, centres, &c. 4. Statics comprehends the whole doctrine of the pressure of fluids, whether liquid or æriform, whether arising from their weight, or from any external action. Hence, therefore, we derive our knowledge of the stability of ships, or their power of maintaining themselves in a position nearly upright, in opposition to the action of the wind on their sails. We learn on what circumstances of figure and stowage this quality depends, and what will augment or diminish it. See DYNAMICS, MECHANICS, &c.

STATION, in practical geometry, &c. is a place pitched upon to make an observation, or take an angle, or such like, as in surveying, measuring heights and distances, levelling, &c. An accessible height is taken from one station; but an inaccessible height or distance is only to be taken by making two stations, from two places whose distance asunder is known. In making maps of counties, provinces, &c. stations are fixed upon certain eminences, &c. of the country, and angles taken from thence to the several towns, villages, &c. In surveying, the instrument is to be adjusted by the needle, or otherwise, to answer the points of the horizon at every station; the distance from hence to the last station is to be measured, and an angle is to be taken to the next station; which process repeated, includes the chief practice of surveying.

STATIONARY, in astronomy, signifies the appearance of a planet, when it seems to remain immoveable on the same point of the zodiac for several days. As the earth, whence we view the motions of the planets, is out of the centre of their orbits, the planets appear to proceed irregularly; being sometimes seen to go forwards, that is, from west to east, which is called the direction; sometimes to go backwards, or from east to west, which is called the retrogradation. Now between these two states there must be an intermediate one, wherein the planet neither appears to go backwards nor forwards, but to stand still, and keep the same place in her orbit; which is called her station: and this will happen, when the line that joins the earth's and planet's centre is constantly directed to the same point in the heavens; that is, when

it keeps parallel to itself. For all right lines, drawn from any part of the Earth's orbit, parallel to one another, do all point to the same star; the distance of these lines being insensible, in comparison of that of the fixed stars.

Saturn is seen stationary at the distance of somewhat more than a quadrant from the Sun; Jupiter at the distance of fifty-two degrees; and Mars at a much greater distance. Saturn is stationary eight days, Jupiter four, Mars two, Venus one and a half, and Mercury a half, though the several stations are not always equal.

STATISTICS, a modern term adopted to express a more comprehensive view of the various particulars constituting the natural and political strength and resources of a country than was usually embraced by writers on political arithmetic. Its principal objects are, the extent and population of a state, the occupation of the different classes of its inhabitants; the progress of agriculture, of manufactures, and of internal and foreign trade; the income and wealth of the inhabitants, and the proportion drawn from them for the public service by taxation; the condition of the poor; the state of schools, and other institutions of public utility; with every other subject, the knowledge of which tends to establish the true civil policy of the country, and consequently to promote its prosperity.

The great change which has taken place in the business of government, since the introduction of the modern system of warfare, by which the time and labour of a considerable number of persons is wholly appropriated to the profession of arms; and, particularly, since the adoption of the borrowing system for defraying the expences of war, has rendered statistical information of much more importance than formerly; the naval and military force which a country is capable of furnishing depending essentially on the state of population and employment, and the public finances becoming, by a continual accumulation of taxes intimately connected with the state of agriculture, consumption, and foreign trade. Many errors and inconsistencies of former statesmen and legislators might have been avoided by a better knowledge of the state of the country; yet, although the utility of cultivating this branch of knowledge has become so obvious, few of the governments of Europe have appeared much disposed to promote statistical inquiries. It will be a subject of wonder to future times, that even in Great Britain, so late as the year 1800, the state of the population, on which its capability of defence so much depended, was a subject of so much uncertainty, as to be estimated by many persons at but little more than half what it was afterward ascertained to be.

As a comparison of such statistical accounts as have been published of the different states of Europe would be in a great degree useless and unsatisfactory, since the violent and essential alterations most of them have recently undergone, we shall confine ourselves to the principal particulars relative to Great Britain, as deduced from public documents, and other authentic sources.

The island of Great Britain is about 590 miles in length, and the circuit of its coast makes about 1800 miles: the part constituting England and Wales is in length, from Newhaven, in Sussex, to Berwick upon Tweed, 355 miles, and in breadth, from the South Foreland, in Kent, to the Land's End, in Cornwall, 325 miles.

The area of England and Wales, computed in acres, has been very differently stated by different authors; for as it has never been ascertained by an actual survey, various modes of computation have been adopted, which have disagreed materially in the result. The following are the principal estimates on this point.

	Acres.
By Sir William Petty	28,000,000
Dr. Grew	46,000,000
Dr. Halley	39,938,500
Templeman	31,648,000
Arthur Young	46,916,000
Rev. H. Beeke	38,498,572

In the returns relative to the poor, laid before the House of Commons in 1804, it was stated, that by the best computation England and Wales contained 58,335 square statute miles, and 37,334,400 statute acres. Scotland, with its islands, contains about 21,000,000 of acres.

The soil of South Britain is annually cropped nearly in the following proportions.

	Acres.
Wheat	3,080,000
Barley and rye	850,000
Oats and beans	2,800,000
Clover, rye-grass, &c.	1,120,000
Turnips, carrots, cabbages, &c.	1,120,000
Fallow	2,100,000
Hop grounds	35,000
Nursery grounds	8,500
Fruit and kitchen gardens	45,000
Pleasure grounds	16,000
	11,174,500

Brought over	11,174,500
Land depastured by cattle	17,000,000
Hedge-rows, copses, and woods	1,600,000
Ways, water, &c.	1,282,100
Cultivated land	31,056,600
Commons and waste	6,277,800
	37,334,400

The number of horses for which duty is paid is 1,780,000. Their annual consumption of food, reckoned by the produce of Acres, is

		Acres each.	Acres.
200,000	pleasure horses	5	1,000,000
30,000	cavalry	5	150,000
1,200,000	husbandry	4	4,800,000
350,000	colts, mares, &c.	3	1,050,000
			7,000,000

The total population of Great Britain, as it appeared by the returns made in 1801, including the army, navy, and merchant seamen, was 10,942,646; to which, if the islands of Guernsey, Jersey, Alderney, and the Scilly islands, are added, it may be taken at 11,000,000. See POPULATION. But it is evident, that the welfare of a nation, and its political strength, do not depend so much on its numerical population, as on the manner in which that population is employed; the proportion of productive to unproductive labourers of which it consists. No accurate account of this kind has ever been taken, but the following estimate of the different classes of persons who compose the present population of Great Britain, cannot be far from the truth:

Nobility and gentry	5,000
Clergy of the churches of England and Scotland	18,000
Ditto dissenters of every description	14,000
Army and militia, including half-pay, &c.	240,000
Navy and marines	130,000
Seamen in the merchant service	155,000
Lightermen, watermen, &c.	3,500
Persons employed in collecting the public revenue	6,000
Judges, counsel, attornies, &c.	14,000
Merchants, brokers, factors, &c.	25,000
Clerks to ditto, and to commercial companies	40,000
Employed in the different manufactures	1,680,000
Mechanics not immediately belonging to ditto	50,000
Shopkeepers	160,000
Schoolmasters and mistresses	20,000
Artists	5,000
Players, musicians, &c.	4,000
Employed in agriculture	2,000,000
Male and female servants	800,000
Gamblers, swindlers, thieves, prostitutes, &c.	150,000
Convicts and prisoners	10,000
Aged and infirm	293,000
Wives and daughters of most of the above	2,427,500
Children under ten years of age	2,750,000
	11,000,000

If these different classes are divided according to the effect produced by their occupations, it will be found that the whole population of the country depends for subsistence, and all the conveniencies of life, on the labour of less than one half of the total number; and the increase or decrease of this productive part of the community, and of the effect of their exertions, is the measure of the increase or decline of that gradual accumulation of stock which constitutes national wealth. In a different state of society, however, this division of the population would vary considerably; for were not those, who are considered as unproductive labourers, employed in their several vocations, their duties, or at least the principal of them, must be divided among those who at present are the efficient labourers; who, thus being obliged to give up part of their time to unproductive purposes, could not perform the same quan-

tity of useful labour as at present; and consequently, to support the same population, a greater number of persons would be compelled to engage, at least partially, in productive employs.

The total income of all classes of the community, both as arising from capital and labour, appears to be nearly as follows:

	£.
From rent of lands	29,000,000
From rent of houses	8,500,000
Profits of farming, or occupation of land	6,120,000
Income of labourers in agriculture	15,000,000
Profits of mines, canals, collieries, &c.	2,000,000
Profits of merchant shipping and small craft	1,000,000
Income of stockholders	20,500,000
From mortgages and other monies lent	3,000,000
Profits of foreign trade	11,250,000
Profits of manufactures	14,100,000
Pay of army, navy, and merchant seamen	5,000,000
Income of the clergy of all descriptions	2,200,000
Judges and all subordinate officers of the law	1,800,000
Professors, schoolmasters, tutors, &c.	600,000
Retail trades not immediately connected with foreign trade or manufactures	8,000,000
Various other professions and employments	2,000,000
Male and female servants	2,400,000
	£. 132,470,000

If this statement, the total of which is corroborated by the produce of the income or property tax, is not far from the truth, it will not be difficult to form a similar estimate of the total national capital, viz.

	£.
Value of the land, at 28 years purchase	812,000,000
Value of houses, at 20 years purchase	170,000,000
Manufactories, machinery, steam engines, &c.	20,000,000
Household funiture	42,500,000
Apparel, provisions, fuel, wine, plate, watches, and jewels; books, carriages, and other articles	40,000,000
Cattle of all kinds	90,000,000
Grain of all kinds	10,600,000
Hay, straw, &c.	6,600,000
Implements of husbandry	2,000,000
Merchant shipping	12,800,000
The navy	6,000,000
Coin and bullion	24,000,000
Goods in the hands of merchants, &c.	16,300,000
Goods in the hands of manufacturers, and retail traders	20,000,000
	£. 1,272,800,000

In the year 1795, Mr. Pitt estimated the total landed property at 750 millions, and personal property at 600 millions, making a total of 1350 millions. But even from the above more moderate statement, in which most of the articles are probably taken rather below than above the truth, it appears that, notwithstanding all the new wants which refinement and fashion have introduced into the general mode of living, and the expensive wars in which the country has been engaged, there has usually been a surplus of the general revenue, which by gradual accumulation has raised the value of the national stock, or capital, to an amount far exceeding any rational estimate of it at former periods.

It is evident that this statement includes

only the real or effective wealth of the country, upon which all other species of wealth, whether consisting in government or private securities, or of any other description, ultimately depend; for private or public loans in which mode a great part of the property of many persons is invested, are obligations on the part of the borrowers to repay, at a future time, a certain sum in money, which is the measure and representative of all other species of real property, or to pay an income arising from this sum till the capital is repaid. The borrower is no otherwise richer than by the greater income he can make of the money borrowed, than what he agrees to pay for it, as the capital whether he invests it in land, merchandise, or any other way, remains the property of the lender, who though he may not by the laws of the country be permitted to take possession of the property into which his money has been converted, may, if necessary, bring it to sale for the purpose of reconverting it into the equivalent sum which he had lent. If, therefore, the whole national stock was in the hands of one half of the inhabitants, who had borrowed the sum of 1272,800,000*l.* of the other half, it is evident that it would be the real property not of those in possession, but of those to whom they were indebted, and this is actually the case with respect to a considerable part of the property of this country; the debts of government having contributed materially to produce this effect.

STATUARY, a branch of sculpture, employed in the making of statues. See SCULPTURE.

Statuary is one of those arts wherein the ancients surpassed the moderns; and indeed it was much more popular, and more cultivated among the former than the latter. It is disputed between statuary and painting which of the two is the most difficult and the most artful. Statuary is also used for the artificer who makes statues. Phidias was the greatest statuary among the ancients, and Michael Angelo among the moderns.

STATUES, are figures representing living or deceased creatures, of whatever species, real or imaginary; and carved, cast, modelled, or moulded, in full relievo, insulated on every part. Statues are formed with the chisel, of several materials, such as marble, stone, &c.: they are carved in wood; or cast in plaster of Paris, or other matter of the same nature; they are also cast in several metals, as lead, brass, silver, and gold.

Statues are divided into colossal, or considerably exceeding the dimensions of nature; as, for instance, the celebrated statue of Apollo at Rhodes. Allegorical, or such as, under human or other symbolical forms, represent subjects of a different kind, as Time, Ocean, Winds; or qualities of an intellectual nature, as Mercy, Justice, &c. &c. Statues of deities, demi-gods, and heroes were, among the ancients, generally represented somewhat larger than life. Monumental, either representing the person, the virtues, or the actions of the deceased. Equestrian, generally of some illustrious person on horseback. Pedestrian, or on foot. The most celebrated statues are those of the Egyptians, Grecians, and Romans.

STATUES, *antique*. The denomination of antique statues is applicable to all ancient statues, found either in India, Egypt, &c. but is especially given, in preference, to the statues wrought by the ancient Greek and Roman sculptors. The works of the Grecians are considered as the most perfect examples of sculpture. Their statues are eminently admirable for the various beauty of their forms, for characteristic expression and grace. The Grecian statues of men are generally naked. The Roman are clothed agreeably to the manner of the country, and are distinguished into palludatæ (statuæ), those of emperors with long robes over their armour; loricatæ, those of soldiers with cuirasses; thoracatæ, those with coats of armour; togatæ, those of magistrates with the toga, or robe worn in office; trabeatæ, those of senators and augurs; tunicatæ, those clothed with a plain tunic; stolatæ, those of women with long trains.

The antique statues are most particularly remarkable for their systematic representation of the human form. As the principle most apparent in their system is that of proportions, we shall give, first, an account of their general proportions to which they chiefly adhered, and next, an accurate measurement of the various parts of the body, taken at Rome, from some of their most celebrated original statues.

"Proportions of the antique Statues." Proportion is the basis of beauty, and there can be no beauty without it; on the contrary, proportion may exist where there is little beauty. Experience teaches us, that knowledge is distinct from taste; and pre-

portion, therefore, which is founded on knowledge, may be strictly observed in any figure, and yet the figure have no pretensions to beauty. The ancients considering ideal beauty as the most perfect, have frequently employed it in preference to the beauty of nature. It is probable that the Grecian as well as the Egyptian artists, determined the great and small proportions by fixed rules; that they established a positive measure for the dimensions of length, breadth, and circumference. This supposition alone can enable us to account for the great conformity which we meet with in ancient statues. Winkelman thinks that the foot was the measure which the antients used in all their great dimensions, and that it was by the length of it that they regulated the measure of their figures by giving to them six times that length. This, in fact, is the length which Vitruvius assigns, lib. 3, cap. 1. That celebrated architect thinks the foot is a more determinate measure than the head or the face, the parts from which modern painters and sculptors often take their proportions. This proportion of the foot to the body, which has appeared strange and incomprehensible to the learned Huetius, and has been entirely rejected by Perrault, is, however, founded upon experience. After measuring with great care a vast number of figures, Winkelman found this proportion not only in Egyptian statues, but also in those of Greece. This fact may be determined by an inspection of those statues the feet of which are perfect; and one may be more fully convinced of it by examining some figures of the Greek divinities; in which the artists have made some parts beyond their natural dimensions. In the Apollo Belvidere, which is a little more than seven heads high, the foot is three Roman inches longer than the head. The head of the Venus de Medicis is very small, and the height of the statue is seven heads and a half; the foot is three inches and a half longer than the head, or precisely the sixth part of the length of the whole statue.

Other writers are of opinion, that the following rules form a principal part of the system of Grecian sculpture: the body consists of three parts, as well as the members. The three parts of the body are, the trunk, the thighs, and the legs. The inferior part of the body are the thighs, the legs, and the feet. The arms also consist of three parts. These three parts must bear a certain proportion to the whole, as well as to one another. In a well-formed man, the head and body must be proportioned to the thighs, the legs, and the feet, in the same manner as the thighs are proportioned to the legs and the feet, or the arms to the hands. The face also consists of three parts, that is, three times the length of the nose; but the head is not four times the length of the nose, as some writers have asserted. From the place where the hair begins to the crown of the head, are only three-fourths of the length of the nose, or that part is to the nose as nine to twelve.

STATUTE, is a written law, made with the concurrence of the King and both houses of parliament. Divers acts of parliament have attempted to bar, restrain, suspend, qualify, or make void the acts of subsequent parliaments: but this could never be effected, for a latter parliament hath ever power to abrogate, suspend, qualify, or make void the acts of a former, in the whole, or any part thereof, notwithstanding any words of restraint or prohibition in the acts of the former.

When a statute is repealed, all acts done under it, while it was in force, are good; but if it is declared null, all those are void. Where a statute, before perpetual, is continued by an affirmative statute for a time, this does not amount to a repeal of it at the end of that time. When two acts contradictory to each other are passed in the same session, the latter only shall take effect. Formerly acts of parliament took effect from the beginning of the session; by a recent statute they have effect from the day on which they are passed.

STATUTES, *construction of*, comprehends the following rules: 1. In the construction of remedial statutes, there are three points which require consideration, *viz.* the old law, the mischief, and the remedy, that is, how the common law stood at the making of the act; what the mischief was, for which the common law did not provide; and what remedy the parliament hath provided to cure this mischief. And it is the business of the judge, so to construe the act, as to suppress the mischief and advance the remedy. An instance may be specified in the restraining statute of 13 Elizabeth, c. 10. By the common law, ecclesiastical corporation, might let as long leases as they thought proper; the mischief was, that they let long and unreasonable leases, to the impoverishment of their successors: the remedy applied by the statute was the mak-

ing void all leases by ecclesiastical bodies for longer terms than three lives, or twenty-one years. In the construction of this statute, it is held, that leases, though for a longer term, if made by a bishop, are not void during the bishop's continuance in his see; or, if made by a dean and chapter, they are not void during the continuance of the dean: for the act was made for the benefit and protection of the successor. The mischief is, therefore, sufficiently suppressed, by vacating them after the determination of the interest of the grantors; but the leases, during their continuance, being not within the mischief, are not within the remedy. 2. A statute, which treats of things or persons of an inferior rank, cannot, by any general words, be extended to those of a superior. Thus, a statute treating of "deans, prebendaries, parsons, vicars, and others having spiritual promotion," is held not to extend to bishops, though they have spiritual promotion, deans being the highest persons named, and bishops being of a still higher order. 3. Penal statutes must be construed strictly. Thus, by the statute 14 George II. c. 6. stealing sheep, or other cattle, was made felony, by benefit of clergy: but, or other cattle, being considered as too loose an expression for creating a capital offence, the act was held to extend to nothing but mere sheep. In the next sessions it was therefore found necessary to make another statute, 15 George II. c. 34. extending the former to bulls, cows, oxen, steers, bullocks, heifers, calves, and lambs, by name. 4. Statutes against frauds are to be liberally and beneficially expounded. 5. One part of a statute must be so construed by another, that the whole may (if possible) stand: "ut res magis valeat, quam pereat." As if land be vested in the king and his heirs by act of parliament, saving the right of A; and A, has at that time a lease of it for three years; here A, shall hold it for his term of three years, and afterward, it shall go to the king. 6. A saving, totally repugnant to the body of the act, is void. If, therefore, an act of parliament vests land in the king and his heirs, saving the right of all persons whomsoever, or vests the land of A, in the king, saving the right of A: in either of these cases the saving is totally repugnant to the body of the statute, and (if good) would render the statute of no effect or operation; and therefore the saving is void, and the land vests absolutely in the king. 7. Where the common law and a statute differ, the common law gives place to the statute, and an old statute gives place to a new one: and this upon a general principle of universal law, that "leges posteriores priores contrarias abrogant;" consonant to which it was laid down by a law of the Twelve Tables at Rome, that "quod populus postumum jussit, id jus ratum esto." This is to be understood only when the latter statute is couched in negative terms, or where its matter is so clearly repugnant, that it necessarily implies a negative. But if both acts be merely affirmative, and the substance such that both may stand together, here the latter does not repeal the former, but they shall both have a concurrent efficacy. 8. If a statute, that repeals another, is itself afterwards repealed, the first statute is hereby revived, without any formal words for that purpose. 9. Acts of parliament, derogatory from the power of subseqhent parliaments, bind not. 10. Acts of parliament, that are impossible to be performed, are of no validity; and if out of them arise collaterally any absurd consequences, manifestly contradictory to common reason, they are, with regard to those collateral consequences, void. See Blackstone's Commentaries.

STATUTE *merchant*, and STATUTE *staple*, are two species of bonds acknowledged upon record before the mayor or clerk of the staple in borough towns, as the case may be; and have the effects of immediate judgments upon the goods, body, and lands of the persons sealing and recording them. They are little used in modern times; but though intended for merchants originally, they may be given by others. Mr. Tidd, in his Practice (1799), vol. ii. p. 978, says, that a *capias ad satisfaciendum*, which lies upon common judgments to take the body of the defendant in execution, lies not against peers or members of parliament, except upon a statute merchant or staple. He cites 1 Cromp, 345; and we presume means, that on such a security they may be personally taken in execution. If this can be so, it would be well to procure peers and members of parliament to grant such securities; upon which tradesmen might stand an ordinary chance of getting their money.

STAUROLITE, in mineralogy. This stone has been found at Andreasberg, in the Hartz. It is crystallized, and the form of its crystals has induced mineralogists to give it the name of cross-stone. Its crystals are two four-sided flattened prisms, terminated

by four-sided pyramids, intersecting each other at right angles; the plane of intersection passing longitudinally through the prism. Sometimes these prisms occur solitary. Primitive form, an octahedron with isosceles triangular faces. The faces of the crystals striated longitudinally. Its texture is foliated. Its lustre glassy. Specific gravity 2.3. Colour milk-white. When heated slowly, it loses 0.15 or 0.16 parts of its weight, and falls into powder. It effervesces with borax and microcosmic salt, and is reduced to a greenish opaque mass. With soda it melts into a frothy white enamel. When its powder is thrown on a hot coal, it emits a greenish yellow light. The constituent parts are

Silica	44
Alumina	20
Barytes	20
Water	16
	100

STAY, in the sea language, a big strong rope fastened to the top of one mast, and to the foot of that next before it, towards the prow, serving to keep it firm, and prevent its falling aftwards, or towards the poop. All masts, top-masts, and flag staves, have their stays, except the sprit-sail top-masts. That of the main-mast is called the main-stay. The main-mast, fore-mast, and those belonging to them, have also back-stays to prevent their pitching forwards, or over-board, as going on either side of her. To stay a ship, or to bring her on the stays, is to manage her tackle and sails so that she cannot make any way forwards; which is done in order to her tacking about.

STEALING, the fraudulent taking away of another man's goods, with an intent to steal them, against, or without the will of him whose goods they are. This is punished, according to circumstances, very differently by the English laws. A late statute, 1808, has altered the punishment for privately stealing from the person, or picking pockets, which was a capital felony, and has made it a simple larceny, subject to transportation only. See BURGLARY, LARCENY, ROBBERY.

STEAM *Engine*, an engine for raising water, or for producing any powerful effect in moving machinery, &c. by the force of steam obtained from boiling water. It is often called a fire-engine, on account, perhaps, of the fire employed in heating the water, in order to throw off the steam. This is unquestionably one of the most useful, curious, and important machines that has ever been invented; and it is thought, that without the aid of this, or some other engine adapted to the same purpose, we should long ere this have been deprived of the benefit of coal fires; as our forefathers, full a century ago, had excavated almost all the mines of that substance as deep as they could be worked, without the aid of some engine to draw water from greater depths. The principle of this machine is as follows: there is a forcing pump with its rod fixed to one end of a lever, which is worked by the weight or pressure of the atmosphere upon a piston at the other end, a temporary vacuum being made below it, by suddenly condensing the steam, that had been let into the cylinder in which this piston works, by a jet of cold water thrown into it. A partial vacuum being thus made, the weight of the atmosphere presses down the piston, and raises the other end of the straight lever with water, &c. from the mine. Then immediately a hole is uncovered in the bottom of the cylinder, by which a fresh supply of hot steam rushes in from the boiler, which acts as a counterbalance for the atmosphere above the piston, and the weight of the pump rods at the other end of the lever carries that end down, and of course raises the piston of the steam cylinder. The orifice for the emission of the steam is immediately shut, and the cock opened for injecting the cold water into the cylinder: this condenses it to water, and another vacuum is made below the piston, which is now again forced down by the weight of the atmosphere, and thus the work is continued so long as water and fuel are supplied.

This is the common principle of the steam engine, but the methods of operation are very various: there is seldom a year that passes away, that we have not new patents obtained for improvements, or professed improvements, of this machine. It is comparatively of modern invention: the earliest account of any one is that in the Marquis of Worcester's History of Inventions, published in the year 1663; the description here is too scanty to work upon, but it furnished the idea, which has afforded to ingenious men of all nations the opportunity of putting forth their skill, and their talents, in executing a number of important improvements on the subject. Captain Savery was the first person who attempted to

realize the noble marquis's project: he made the pressure of steam act immediately on the surface of water contained in a close vessel, and the water was forced, by the elasticity of the steam, to ascend through a pipe. The objection to this was the great heat required for raising water to any considerable height: and also the waste of steam by its coming in contact with the cold water in the receiver, the surfaces of which required to be heated to its own temperature, before the water could be expelled. These inconveniences were in a great measure avoided in Newcomen's engine, where the steam was gradually introduced into a cylinder, and suddenly condensed by a jet of water, so that the piston was forced down with great violence by the pressure of the atmosphere, which produced the effective stroke: this effect was, however, partly employed in raising a counterpoise, which descended upon the readmission of the steam, and worked a forcing pump in its return, when water was to be raised. Engines on this principle were commonly used in this country, till the improvements on them were introduced by Mr. Watt, to whom the public, in this business, is more indebted than to any other person. The engines constructed by this gentleman are said to save three-fourths of the fuel that was used in the best constructed engines of Newcomen, with the waste of only one fourth of the steam. He has contrived to observe an uniform heat in the cylinder of his engines, by suffering no cold water to touch it, and by protecting it from the air, or other cold bodies, by a surrounding case filled with steam, or with hot air, or water, and by coating it over with substances that conduct the heat very slowly and imperfectly. He makes his vacuum to approach nearly in excellence to that of a barometer, by condensing the steam in a separate vessel, called the condenser, which may be cooled at pleasure, without cooling the cylinder, either by an injection of cold water, or by surrounding the condenser with it. He extracts the injection water, and detached air, from the cylinder, or condenser, by pumps, which are worked by the engine itself. As the entrance of air into the cylinder would stop, or very much impede, the operation of the engines, and as it is almost impossible to expect such pistons to be absolutely air-tight, a stream of water used to be kept running on the piston, to prevent the entry of the air, as the lighter fluid could not descend through the heavier: this mode, which was not injurious to the engines on the old construction, could not fail to injure the modern ones of Mr. Watt. He therefore makes his pistons more accurately; and the outer cylinder, having a lid, which covers it, the steam is introduced above the piston, and when a vacuum is produced under it, acts upon it by its elasticity, as the atmosphere does upon common engines by its gravity. This method of working effectually excludes the air from the inner cylinder, and gives the advantage of adding to the power, by increasing the elasticity of the steam. We shall endeavour to give our readers an idea of the manner in which Mr. Watt's engine works, and then present them with an accurate description, accompanied with engravings of one, to which our draftsman has had access for the purpose.

The cylinder in Mr. Watt's engines is very accurately bored, and surrounded at a small distance with another cylinder furnished with a bottom and lid. The interval between the cylinders communicates with the boilers by a large pipe, open at both ends, so that it is always filled with steam, and thereby keeps the inner cylinder at the same temperature as that of the steam, and prevents any condensation. The inner cylinder has a bottom and piston as usual; and as it does not reach quite up to the lid of the outer cylinder, the steam in the interval has always free access to the upper side of the piston. The lid of the outer cylinder has a hole in its middle; and the piston rod, which is truly cylindrical, moves up and down through that hole, which is kept steam-tight by a collar of oakum screwed down upon it. At the bottom of the inner cylinder there are two regulating valves, one of which admits the steam to pass from the interval into the inner cylinder below the piston, or shuts it out at pleasure: the other opens or shuts the end of a pipe, which leads to the condenser. The condenser consists of one or more pumps, furnished with clacks and buckets, which are worked by chains fastened to the great working beam of the engine. The pipe which comes from the cylinder is joined to the bottom of these pumps, and the whole condenser stands immersed in a cistern of cold water, supplied by the engine. The place of the cistern is either within the house or under the floor, between the cylinder and the lever wall; or without the house, between that wall and the engine shaft. The condenser being exhausted of

air, and both cylinders filled with steam, the regulating valve which admits the steam into the inner cylinder is shut, and the other regulator which communicates with the condenser is opened, and the steam rushes into the vacuum of the condenser with violence: but there it comes into contact with the cold sides of the pumps and pipes, and meets a jet of cold water, which was opened at the same time with the exhaustion regulator: these instantly deprive it of its heat, and reduce it to water; and the vacuum remaining perfect, more steam continues to rush in, and is condensed till the inner cylinder is exhausted. Then the steam which is above the piston, ceasing to be counteracted by that which was below it, acts upon the piston with its whole elasticity, and forces it to descend to the bottom of the cylinder, and so raises the buckets of the pumps, which are hung to the other end of the beam. The exhaustion regulator is now shut, and the steam one opened again; which, by letting in the steam, allows the piston to be pulled up by the superior weight of the pump rods, and then the engine is ready for another stroke.

The peculiar advantages that result from this construction are, that the cylinder being surrounded with the steam from the boiler, is kept always uniformly as hot as the steam itself, and is, therefore, incapable of destroying any part of the steam which should fill it: and again, the condenser being kept always as cold as water can be procured, the steam is perfectly condensed, and does not oppose the descent of the piston; which is, therefore, forced down by the full power of the steam from the boiler, which is greater than that of the atmosphere.

A steam-engine of the best construction, with a thirty inch cylinder, acts with the force of 40 horses; and since it acts without intermission, will perform the work of 120 horses, or of 600 men; each square inch of the piston being nearly equivalent to a labourer. The consumption of about 84*lb.* of good pit coal, will raise 48,000 cubical feet of water 10 feet high, which is equivalent to more than the daily labour of eight men: the value of this quantity of coal is seldom so much as that of the work of a single labourer for a day; but the expense of the machinery generally renders a steam-engine somewhat more than half as expensive as the number of horses for which it is substituted. We shall now proceed to a more particular description.

Plates I and II. Steam Engine, are drawings of a steam-engine of six-horses power, built by Mr. John Dixion, Maid Lane, Southwark, and used by him in his steam-engine manufactory, for turning lathes, &c. Plate I. is a general elevation of the whole engine; and Plate II. is a section on a larger scale of the cylinder steam pipes, condenser, &c.; *b b*, Plate I. is the cylinder, the internal structure will be described hereafter; *a* is the piston rod connected to the great working beam, B, by a system of levers called a parallel motion, the property of which is, that the rectilinear motion of the piston rod is preserved, though the end of the beam describes an arc of a circle; at the other end of the beam, B, the connecting rod, D, is jointed at its lower end; it is also jointed to the crank, E, upon the axis of the great fly-wheel. When by the expansive force of the steam, the piston rod, *a*, is caused to ascend, it raises one end of the great beam and depresses the other, and by the connecting rod, D, turns the crank and fly wheel round. As soon as the piston rod arrives at the top of its stroke, it receives a new impulse, which brings it down again, and consequently raises the connected rod, D, and crank, E. The use of the fly wheel is to acquire an impetus, at the time when the crank is horizontal, and at which time the connecting rod exerts all the force of the engine upon the crank to turn it round, this momentum causes the wheel to turn, and the rest of the machinery, when the crank is at the top or bottom of its motion, being then in a line with the connecting rod, it has no tendency to turn it round.

To describe the manner in which the power is given to the piston rod, *a*, we must turn to Plate II. where *b b b b* is the cylinder of cast iron, and truly bored, it is closed at the top by an iron lid screwed on by a flanch at the top; in the centre of the lid is a contrivance called a stuffing box, and is for holding a packing of hemp, through which the piston rod, *a a*, passes perfectly air and steam tight; *d d* is the piston packed with hemp, round between its circumference and the inside of the cylinder, so that it can move up and down in the cylinder easily, without allowing any steam to pass by it; the piston is fitted to the rod, *a*, and fast keyed in; the cylinder has a flanch or projecting ring round it, a little below the middle, by which it is held into a jacket, *c c c*, which is constantly supplied with steam from the boiler, A; Plate I. of the engine of the pipe, *e*; *f f*, Plate II. is a pipe, cast

at the same time with the cylinder, leading from the top of it, and by a crooked passage; to the cock, E; *g g* is another similar passage from the bottom of the cylinder (which is closed except this pipe has an iron bottom screwed to it) to the cock, and enters the cock diametrically opposite to the other passage; *h* is a passage bringing steam from the jacket, *c c c*; by means of a short pipe not seen in the figure, being behind the cylinder, cast at the same time with the cylinder, and joining at the bottom to the flanch, by which the cylinder is screwed into the jacket, *c c c;* the bore of this short pipe is however continued through the flanch, and opens into the jacket, and when they are screwed together the steam has then free access from the boiler through the jacket into the short pipe, and from thence into the passage, *h*, which goes horizontal towards it; the short pipe has a thin circular vane in it, turning on a pivot across the centre of it, which comes through the pipe, and has a handle on it; by turning this handle the spindle and vane are turned also; when the vane is set, so that its plane is perpendicular to the axis of the pipe, it nearly fills the circular passage, and allows very little steam to pass by it; but when the vane is turned edgeways, it presents very little surface, and the steam passes by without obstruction to the cock, E; *p p p* is a pipe conveying the steam away from the engine, to the condenser, which is an iron cylinder, F F, immersed in cold water, contained in a cast iron cistern, G G; the condenser, F F, has a passage from the bottom of it, leading to a pump, H H, called the air-pump, and in which is a valve, *i*, shutting towards the condenser, and preventing any passage from the air-pump to the condenser, though the valve will easily open and allow a passage the other way. The air-pump has a bucket, *k*, sliding up and down in it; the bucket has a hole through it, covered by a valve, *l*, which opens upwards, and prevents the descent of any fluid which may be above it; I is a square iron cistern screwed on the top of the air-pump, it has a stuffing box in the bottom over the centre of the pump, through which the bucket rod of the air-pump moves freely, yet perfectly air-tight; the bottom of the cistern, I, has also two valves, *m m*, in it, over the air-pump; K is a handle fixed upon a spindle, on which is a rack turning a cog-wheel upon the end of the cock, E; this rack and wheel is taken away in the section, but is plainly seen in Plate I.; L M are two pins fixed upon the rod of the air-pump, and taking the handle, K, as they move up and down, and thus turning the cock, E; *n n* is a lever fixed on the spindle of the handle, K, its ends stop against the ends of a crooked iron, which is screwed to the iron frame, supporting the bearings for the spindle of the rack, so that the motion allowed thereby to the handle, K, and the rack, will turn the cock one-fourth of a whole turn, but no more; N is a cock communicating (when open) from the jacket, *c c*, to the pipe, *pp*, and thereby to the condenser.

The condenser, F F, has a pipe entering it, and turned up within it, the pipe opens to the water in its condensing cistern, G G, and has a cock in its outer end which regulates the quantity of water the pipe will admit, or closes it entirely; the cock has a long handle coming up out of the water, which is not seen in the section; but is denoted by *o*, in Plate I.

Suppose every thing in the position of the section, the operation of the engine is as follows: when the water, in the boiler A, Plate I. is heated by the fire made under it at X, the heat which enters into combination with the water, causes it to expand and form steam; in this state it raises and fills the boiler, and thence through the pipe, *e*, enters between the jacket, *c c*, and the cylinder; before the engine can be worked, the steam must be heated, until it is expanded so much, that it will rush forcibly out of the boiler when permitted. The steam also passes through the short pipe before described, into the passage, *h*, and thence, through the crooked passage in the cock, F, to the pipe, *g g*, and the bottom of the cylinder, though it will not enter the cylinder, because it is yet filled with air.

The person who attends the engine must now open the cock, N, this admits the steam from the boiler into the condenser; it rushes violently through the pipe, *p p*, into the condenser, F F, driving the air it contained through the three valves, *i*, *l*, and *m*, which it opens, into the cistern, I, (where it is open to the atmosphere, the lid of that cistern being only laid on, and not fitting tight) this operation (called blowing through) continued for a few seconds, expels all the air from the condenser, and fills it with hot steam; the cock, N, is now closed, and the injection cock, of which O, Plate I. is the handle, is opened; this allows a small stream of cold water, from the cistern, G, to enter into the condenser,

and condenses the steam, or cools it, and it instantly contracts into the same space it originally occupied when in the boiler, before it was heated. As the valve, i, closes, it is evident that a vacuum will be caused in the condenser, as the small quantity of water produced from the steam, and the water injected into the condenser falling down to the bottom, the air in the upper part of the cylinder will now expand itself into the condenser, through the pipe, *ff*, the cock, E, and pipe, *pp*, and as it occupies more space than it did before, it will be considerably rarified; the stream, pressing with its full force against the lower side of the piston, will, perhaps, (now a rarefaction is made above it), overcome the resistance of the work and friction, and cause it to ascend, the air-pump rod and bucket moving with it, when the pin, M, upon this rod, reaches the handle, K, it raises it up, and, by means of the rack and wheel shown in Plate I. turns the cock, E, one-fourth of a revolution, bringing its two passages into the position of fig. 2, Plate II.

The operation is now reversed, the steam from the boiler going above the piston, and that steam, mixed with atmospheric air, beneath it going to the condenser, where the steam will be condensed, and a partial vacuum formed beneath the piston; the steam now presses it down, moving the beam fly-wheel and other machinery, it has to drive; when the pin, L, on the air pump rod arrives at the handle, K, it presses it down, and brings the cock into the position of the figure 1, in which the piston will be driven up again. At each stroke of the engine, when the piston rises, the valve, *i*, on the bucket of the air pump, will shut, and all the air and water contained above the bucket, will be lifted through the valves, *m m*, into the cistern, I, at the same time a vacuum being made beneath the bucket, which is more perfect than that in the condenser, the valve, *i*, will be opened by the water and air in the condenser, which will enter the pump. On the ascent of the piston and the air pump bucket, the valves, *m m* and *i*, will shut, the pressure which opened them being removed, and the water and air in the pump pressing upon the valve, *l*, will open it, and get through as the bucket descends; at its return it raises the water and air above it as before. In this manner, when the engine has made a few strokes, all the air contained in the engine at the commencement of the operation will be pumped out; the operation of the engine is now much more perfect. The instant the cock, E, is turned, so as to open a communication from the cylinder full of steam to the condenser; the elasticity of the steam causes it to rush down the pipe, *p p*, into the condenser; when it arrives there, it meets the stream of the injection water, which condenses it, and the remaining steam in the cylinder follows it surprisingly quick, and in an instant an almost perfect vacuum is formed in the cylinder, so that the steam acts with its whole force upon the piston, all resistance upon the other side being removed. The air pump now has only to draw off from the condenser the water injected into it, the condensed steam, and a small quantity of gas, which goes from the boiler with the steam, and will not condense by the cold water; these are delivered by the air pump into the cistern, I, from which the air escapes, the cover not being tight (as before mentioned), the water which still continues hot runs off, when at a certain level, by a waste pipe, *o*, Plate I. The water which is boiled off in steam from the boiler, is renewed from this cistern by means of a small pump, P, Plate I, which draws the water from it by a passage through the centre of the cast iron column, Q, which stands upon the end of the condensing cistern, G G, and supports the bearing for the main axis of the great beam, B, the water is conveyed to the bottom of the column by a short pipe, *r*, and after going through the pump, P, is carried by the pipes, R R R, to a cistern on the top of the vertical pipe, S, which leads into the boiler. The top of S is closed by a valve in the cistern, which is raised by means of a lever, the other end of which has a wire, *y*, hooked to it, going through a small stuffing box into the boiler, where it has a stone hung on it; this stone is balanced by a weight hung at the other end of the lever, so that when the stone is covered with water, the weight keeps the valve shut, and prevents any water getting down into the boiler: but as the water sinks in the boiler, the weight of the stone overcomes the weight, and opens the valve; the water in the cistern now runs down the pipe, S, into the boiler, and raises the water and the stone until it closes the valve.

It will be easily seen that by the condenser being constantly supplied with hot steam, which will give out its heat, and at length render the water surrounding it, in the cistern, G, so hot, that it would condense no more; to prevent this, it is con-

stantly supplied with cold water from a pump, T, worked by a rod from the great beam, B; the water from the cistern runs off by a waste pipe at the back of the cistern, not seen in the figures. V is a short pipe upon the boiler, with a lid and stuffing box, a rod passes through it, and has a valve within it, pressed down by a lever and weight, *v*. If at any time, when the engine is not at work, the steam should be heated, so as to be in any danger of bursting the boiler, the valve will lift up the weight, and allow the steam to escape through the pipe, W, into the open air. Y, a lid screwed down upon a hole in the boiler, through which a man enters the boiler to clean it occasionally. At Z are two cocks upon the ends of pipes going down into the boiler; one pipe is longer than the other, the longest reaches into the water, and the short one does not; these cocks are to show the height of the water in the boiler, when one is turned (if the water is the proper height); it will deliver steam, and the other water.

It may be observed, that when the engine is once set to work, the lever, *n u*, on the spindle of the rack is of no use, as the instant the cock is turned one-fourth round, the piston and engine begins to return.

STEATITE, in mineralogy, a species of the Talc genus, is of a white colour; but it presents several varieties through the greys, greens, and reds. It occurs massive, disseminated, in crusts, and crystallized. The crystals are six-sided prisms, acuminated on both extremities by six planes. Specific gravity 2.6. The constituent parts are, according to Klaproth,

Silica	48.0
Magnesia	20.5
Oxide of iron	1.0
Water	15.5
Alumina	14.0
	99.0
Loss	1.
	100

Before the blow-pipe it loses its colour, and becomes hard; but is infusible without addition. It occurs in beds and veins in serpentine, also in irregular shaped pieces, imbedded in rocks belonging to the floetz formation. It is found in Norway, Sweden, several parts of Germany, and in the united kingdom of Great Britain; also in China. It is used in the manufacture of porcelain: other varieties are used in fulling, and the Chinese work it into vessels of various shapes.

STEEPLE, an appendage erected generally on the western end of a church, to hold the bells. Steeples are denominated from their form, either spires or towers; the first are such as ascend continually diminishing either conically or pyramidally. The latter are mere parallelopipeds, and are covered a-top platform-like. In each kind there is usually a sort of windows, or apertures, to let out the sound, and so contrived at the same time as to drive it down.

STEERAGE, on board a ship, that part of the ship next below the quarter-deck, before the bulk-head of the great cabin, where the steersman stands in most ships of war. See the next article.

STEERING, in navigation, the directing a vessel from one place to another by means of the helm and rudder. He is held the best steersman who causes the least motion in putting the helm over to and again, and who best keeps the ship from making yaws, that is, from running in and out. The perfection of steering, indeed, consists in a vigilant attention to the motion of a ship's head, so as to check every deviation from the line of her course in the first instant of motion, and in applying as little of the power of the helm as possible. By this she will run more uniformly in a straight path: whereas, if a greater effort of the helm is employed it will produce a greater declination from the course, increase the difficulty of steering, and make a crooked and irregular track through the water. There are three methods of steering: 1. By any mark on the land, so as to keep the ship even by it. 2. By the compass, which is by keeping the ship's head on such a rhumb or point of the compass, as best leads to port. 3. To steer as one is bidden, or conned, which, in a great ship, is the duty of him who is taking his turn at the helm. It is the duty of the steersman to watch the head of the ship, by the land, by clouds, and by the heavenly bodies; because, though the course is in general regulated by the compass, the vibrations of the needle are not so instantly perceived as the sallies of the ship's head to the right or the left.

STELLARIA, in botany, *stitchwort*, a genus of the Decandria Trigynia class and order. Natural order of Caryophyllei. Caryophylleæ, Jussieu. Essential character: calyx five-leaved, spreading; petals five, two-parted; capsule superior, one-celled, many-seeded, six-toothed at top. There are seventeen species.

STELLATÆ, in botany, the name of the

forty-seventh order in Linnæus's Fragments of a Natural Method, consisting of plants with two naked seeds, and leaves disposed round the stem in the form of a radiant star. In this order are found the Anthospermum, amber tree: Galium, ladies bedstraw, &c. This order contains herbs, shrubs, and trees. The herbs are chiefly annual, and creep along the surface of the ground: the shrubs and trees are evergreens, which rise erect, and are of an agreeable conic form.

STELLERA, in botany, so named in memory of George Wilh. Steller, adjunct of the Academy at Petersburgh, a genus of the Octandria Monogynia class and order. Natural order of Veprecul æ. Thymelææ, Jussieu. Essential character: calyx none; corolla four-cleft; stamens very short; nut one, beaked. There are two species; *viz.* S. passerina, flax-leaved Stellera; and S. chamæjasme, Siberian Stellera.

STEM, in botany, that part of a plant arising out of the root, and which sustains the leaves, flowers, fruits, &c.

STEM *of a ship*, that main piece of timber which comes bending from the keel below, where it is scarfed, as they call it; that is, pieced in; and rises compassing right before the forecastle. This stem it is which guides the rake of the ship, and all the but-ends of the planks are fixed into it. This, in the section of a first-rate ship, is called the main-stem.

STEMODIA, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: calyx five-parted; corolla two-lipped; stamens four, each filament bifid, two-anthered; capsule two-celled. There are four species.

STEMPLES, in mining, cross-bars of wood in the shafts which are sunk to mines. In many places the way is to sink a perpendicular hole or shaft, the sides of which they strengthen from top to bottom with woodwork, to prevent the earth from falling in; the transverse pieces of wood used for this purpose, they call stemples, and by means of these the miners, in some places, descend without using any rope, catching hold of these with their hands and feet.

STERBECKIA, in botany, so named in memory of Francis van Sterbeck, a genus of the Polyandria Monogynia class and order. Natural order of Guttiferæ, Jussieu. Essential character: calyx three or five-leaved; corolla three or five-petalled; capsule corticose, not opening, legume-shaped, many seeded; seeds imbricate, nestling in pulp. There is only one species; *viz.* S. lateriflora. This is a scandent shrub; leaves sub-opposite, petioled, elliptic, acuminate, quite entire, veined, smooth; peduncles many-flowered, very short, lateral; flowers white and small. It is a native of the woods of Guiana.

STERCULIA, in botany, a genus of the Dodecandria Monogynia class and order. Natural order of Tricoccæ. Malvaceæ, Jussieu. Essential character: calyx five-parted; corolla none; nectary bell-shaped, five-toothed, staminiferous, fastened to the column of the germ; germ pedicelled; capsules five, one-celled, opening by the inner side, many-seeded. There are eight species, among which we shall notice the S. balanghas: this is a tall tree, with a stem of two feet in diameter, thick branches, covered with an ash-coloured bark, furnished with alternate, smooth, veined, lanceolate leaves, which are produced only at the upper part of the shoots, and are in general about nine inches long and three broad; the flowers are produced in sparse fascicles at the tips of the shoots; the capsules are rather large, smooth, ovate, standing by fives in a stellated direction; each capsule containing six, seven, or eight moderately large round seeds. It is a native of Malabar, Amboyna, &c.

STEREOGRAPHIC *projection*, is the projection of the circles of the sphere on the plane of some one great circle, the eye being placed in the pole of that circle.

STEREOGRAPHY, the art of drawing the forms and figures of the solids upon a plane.

STEREOMETRY, that part of geometry which teaches how to measure solid bodies, *i. e.* to find the solidity or solid content of bodies, as globes, cylinders, cubes, vessels, ships, &c.

STEREOTYPE *printing*. See PRINTING, *stereotype*. In the beginning of that article an error escaped our notice, for "*by* the Jesuits," read "*say* the Jesuits." We take likewise this opportunity of adding to the article, that though there have unquestionably issued many beautiful specimens of printing from the stereotype press; yet, as the beauty of a book must depend as well in the stereotype, as in moveable types, on the form and excellence of the letter, it is evident that the same letter from which the stereotype plate is cast, will in common printing produce as beauti-

ful a page: of this we could adduce many instances; but, perhaps, no person has sent from his office more specimens of this kind than the printer of this dictionary.

STERLING, a term frequent in British commerce. A pound, shilling, or penny, sterling, signifies as much as a pound, shilling, or penny of lawful money of Great Britain, as settled by authority.

STERN *of a ship*, usually denotes all the hindermost part of her, but properly it is only the outmost part abaft.

STERN *fast*, denotes some fastenings of ropes, &c. behind the stern of a ship, to which a cable, or hawser, may be brought or fixed, in order to hold her stern to a wharf, &c.

STERN *post*, a great timber let into the keel at the stern of a ship, somewhat sloping, into which are fastened the after-planks; and on this post, by its pintle and gudgeons, hangs the rudder.

STERNA, the *tern*, in natural history, a genus of birds of the order Anseres. Generic character: bill straight, pointed, and slender; nostrils linear; tongue slender and pointed; wings very long; back toe small; tail forked. There are twenty-five species. The following are the principal: S. caspia, or the Caspian tern; this abounds on the seas wherein it derives its name. It fishes also in rivers, and sometimes suddenly darts upon its prey from a considerable height, and at other times skims the surface of the water in the manner of a swallow. It is nearly two feet in length. It lays only two eggs, and its sound resemble those of a person laughing.

S. stolida, or the noddy, is a foot and a quarter long, and is frequently met with at sea, between the tropics. It lays its eggs on the bare ground; is considered by navigators as generally indicating the neighbourhood of land; often alights on the yards and rigging of vessels; will suffer itself to be taken by the hand; and from the general want of sagacity which it exhibits, is called by sailors by the name of noddy. It will, however, notwithstanding its alledged tameness and stupidity, often bite with great severity.

S. hirundo, the great tern, is found in various parts of Europe, and in summer on the British coasts. It is fourteen inches long. Its manners, on the water, resemble those of the swallow by land. It skims along precisely in the same manner, catching every insect in its progress; and when it perceives a fish, it darts into the water and reverts to the air with a rapidity truly astonishing. It is bold and daring; and, in the season of incubation, will attack persons who have given it no molestation, and are at a distance from its nest. For the lesser tern, see Aves, Plate XIII. fig. 7.

STERNOPTYX, in natural history, a genus of fishes of the order Apodes. Generic character: head obtuse; mouth abrupt; teeth very small; no gill-membrane; body compressed, without visible scales; breast carinate, both ways folded; abdomen pellucid. The transparent sternoptyx, the only species under this genus, is between two and three inches long, and is found in the American Seas. Its back rises into a sharp edge. Its general colour is that of a bright silver, but on the back it is somewhat olive coloured, and its fins and tail are of an obscure yellow; its tail is bifid. See Pisces, Plate VI. fig. 2.

STEW, a small kind of fish-pond, the peculiar office of which is to maintain fish, and keep them in readiness for the daily use of a family, &c. The fish bred in the large ponds are drawn out and put in here. For two large ponds, of three or four acres a-piece, it is advisable to have four stews, each two rods wide, and three long. The stews are usually in gardens, or at least near the house, to be more handy, and the better looked to. The method of making them is to carry the bottom in a continued decline from one end, with a mouth to favour the drawing with a net.

STEWARD, an officer appointed in another's stead or place, and always taken for a principal officer within his jurisdiction. Of these there are various kinds. The greatest officer under the crown is the Lord High Steward of England, an office that was anciently the inheritance of the Earls of Leicester, till forfeited by Simon de Mountfort, to King Henry III. But the power of this officer is so very great, that it has not been judged safe to trust it any longer in the hands of a subject, excepting only *pro hac vice*, occasionally: as to officiate at a coronation, at the arraignment of a nobleman for high-treason, or the like. During his office, the Steward bears a white staff in his hand, and the trial, &c. ended, he breaks the staff, and with it his commission expires. There is likewise a Lord Steward of the King's household, who is the chief officer of the King's court, has the care of the King's house, and authority over all the officers and servants of the

household, except such as belong to the chapel, chamber, and stable.

There is also a Steward of the Marshalsea, who has judicial authority. And in most corporations, and all houses of quality in the kingdom, there is an officer of the name and authority of a steward.

The steward of a ship is he who receives all the victuals from the purser, and is to see it well stowed in the hold; all things of that nature belonging to the ship's use are in his custody; he looks after the bread, and distributes out the several messes of victuals in the ship; he hath an apartment for himself in the hold, which is called the steward's room.

STEWART (the Rev. Dr. MATTHEW), in biography, late professor of mathematics in the University of Edinburgh, was the son of the Rev. Mr. Dugald Stewart, minister of Rothsay, in the Isle of Bute, and was born at that place in the year 1717. After having finished his course at the grammar school, being intended by his father for the church, he was sent to the University of Glasgow, and was entered there as a student in 1734. His academical studies were prosecuted with diligence and success; and he was so happy as to be particularly distinguished by the friendship of Dr. Hutcheson, and Dr. Simson the celebrated geometrician, under whom he made great progress in that science.

Mr. Stewart's views made it necessary for him to attend the lectures in the University of Edinburgh in 1741; and that his mathematical studies might suffer no interruption, he was introduced by Dr. Simson to Mr. Maclaurin, who was then teaching both the geometry and the philosophy of Newton, and under whom Mr. Stewart made that proficiency which was to be expected from the abilities of such a pupil, directed by those of so great a master. But the modern analysis, even when thus powerfully recommended, was not able to withdraw his attention from the relish of the ancient geometry, which he had imbibed under Dr. Simson. He still kept up a regular correspondence with this gentleman, giving him an account of his progress, and of his discoveries in geometry, which were now both numerous and important, and receiving in return many curious communications with respect to the Loci Plani, and the Porisms of Euclid. Mr. Stewart pursued this latter subject in a different and new direction. In doing so, he was led to the discovery of certain curious and interesting propositions, which he published under the title of "General Theorems," in 1746. They were given without the demonstrations; but they did not fail to place their discoverer at once among the geometricians of the first rank. They are, for the most part, Porisms, though Mr. Stewart, careful not to anticipate the discoveries of his friend, gave them only the name of Theorems. They are among the most beautiful, as well as most general propositions, known in the whole compass of geometry, and are perhaps only equalled by the remarkable locus to the circle in the second book of Apollonius, or by the celebrated theorem of Mr. Cotes.

In September, 1747, he was elected professor of mathematics in the University of Edinburgh. The duties of this office gave a turn somewhat different to his mathematical pursuits, and led him to think of the most simple and elegant means of explaining those difficult propositions, which were hitherto only accessible to men deeply versed in the modern analysis. In doing this, he was pursuing the object which, of all others, he most ardently wished to attain, viz. the application of geometry to such problems as the algebraic calculus alone had been thought able to resolve. His solution of Kepler's problem was the first specimen of this kind which he gave to the world. This is founded on a general property of curves, which, though very simple, had perhaps never been observed; and by a most ingenious application of that property, he shows how the approximation may be continued to any degree of accuracy, in a series of results which converge with great rapidity.

This solution appeared in the second volume of the Essays of the Philosophical Society of Edinburgh, for the year 1756. In the first volume of the same collection, there are some other propositions of Mr Stewart's, which are an extension of a curious theorem in the fourth book of Pappus. They have a relation to the subject of Porisms, and one of them forms the ninety-first of Dr. Simson's Restoration.

He next published the "Tracts, Physical and Mathematical." In the first of these, Mr. Stewart lays down the doctrine of centripetal forces, in a series of propositions, demonstrated (if we admit the quadrature of curves) with the utmost rigour, and requiring no previous knowledge of the mathematics, except the elements of plane geometry, and of conic sections. The good

order of these propositions, added to the clearness and simplicity of the demonstrations, renders this tract perhaps the best elementary treatise of physical astronomy that is any where to be found.

In the three remaining tracts, our author had it in view to determine the effect of those forces which disturb the motions of a secondary planet. From this he proposed to deduce, not only a theory of the moon, but a determination of the sun's distance from the earth. The former, it is well known, is the most difficult subject to which mathematics have been applied, and the solution required and merited all the clearness and simplicity which our author possessed in so eminent a degree. It must be regretted therefore that the decline of Dr. Stewart's health, which began soon after the publication of the tracts, did not permit him to pursue this investigation. The other object of the tracts was, to determine the distance of the sun, from his effect in disturbing the motions of the moon; and his inquiries into the lunar irregularities had furnished him with the means of accomplishing it as he supposed: and in 1763, he published his "Essay on the Sun's Distance," where the computation being actually made, the parallax of the sun was found to be no more than 6″ 9‴, and consequently his distance almost 29,875 semidiameters of the earth, or nearly 119 millions of miles. A determination of the sun's distance, that so far exceeded all former estimation of it, was received with surprise, and the reasoning on which it was founded was likely to undergo a severe examination. But, even among astronomers, it was not every one who could judge in a matter of such difficult discussion. Accordingly, it was not till about five years after the publication of Dr. Stewart's work that there appeared a pamphlet, under the title of "Four Propositions," intended to point out certain errors in Dr. Stewart's investigation, which had given a result much greater than the truth. From his desire of simplifying, and of employing only the geometrical method of reasoning, he was reduced to the necessity of rejecting quantities, which were considerable enough to have a great effect on the last result. An error was thus introduced, which, had it not been for certain compensations, would have become immediately obvious, by giving the sun's distance near three times as great as that which has been mentioned.

The "Sun's Distance" was the last work which Dr. Stewart published; and though he lived to see the animadversions made on it, he declined entering into any controversy. His disposition was far from polemical; and he knew the value of that quiet, which a literary man should rarely suffer his antagonists to interrupt. He used to say, that the decision of the point in question was now before the public; that if his investigation was right, it would never be overturned, and that if it was wrong, it ought not to be defended.

A few months before he published the Essay just mentioned, he gave to the world another work, entitled, "Propositiones More Veterum Demonstratæ." It consists of a series of geometrical theorems, mostly new; investigated, first by an analysis, and afterwards synthetically demonstrated by the inversion of the same analysis. This method made an important part in the analysis of the ancient geometricians; but few examples of it have been preserved in their writings, and those in the "Propositiones Geometricæ" are therefore the more valuable.

Doctor Stewart's constant use of the geometrical analysis had put him in possession of many valuable propositions, which did not enter into the plan of any of the works that have been enumerated. Of these, not a few have found a place in the writings of Dr. Simson, where they will for ever remain, to mark the friendship of these two mathematicians, and to evince the esteem which Dr. Simson entertained for the abilities of his pupil. Many of these are in the work upon the Porisms, and others in the Conic Sections, *viz*, marked with the letter *x*; also a theorem in the edition of Euclid's Data.

Soon after the publication of the "Sun's Distance," Dr. Stewart's health began to decline, and the duties of his office became burdensome to him. In the year 1772, he retired to the country, where he afterwards spent the greater part of his life, and never resumed his labours in the university. He was however so fortunate as to have a son to whom, though very young, he could commit the care of them with the greatest confidence. Mr. Dugald Stewart, having begun to give lectures for his father from the period above mentioned, was elected joint professor with him in 1775, and gave an early specimen of those abilities, which have not been confined to a single science.

After mathematical studies (on account of the bad state of health into which Dr.

Stewart was falling) had ceased to be his business, they continued to be his amusement. The analogy between the circle and hyperbola had been an early object of his admiration. The extensive views which that analogy is continually opening; the alternate appearance and disappearance of resemblance in the midst of so much dissimilitude, make it an object that astonishes the experienced, as well as the young geometrician. To the consideration of this analogy therefore the mind of Dr. Stewart very naturally returned, when disengaged from other speculations. His usual success still attended his investigations; and he left among his papers some curious approximations to the areas, both of the circle and hyperbola. For some years toward the end of his life, his health scarcely allowed him to prosecute study even as an amusement. He died the twenty-third of January, 1785, at sixty eight years of age. See vol. i. Edinburgh Transactions.

STHENIA, a term employed by the followers of Dr. Brown, to denote that state of the body which disposes to inflammatory diseases, in opposition to those of debility which arise from asthenia. Dr. Struve, in his work on the "Art of prolonging the Life of incurable Persons," gives a few of the theorems after the manner of Brown. He says a stronger stimulus does not, as is commonly believed, destroy a weaker; it only lessens, in a greater or less degree, the force of the latter. Sthenia is always more violent when it is preceded by a considerable asthenia, and *vice versa.* A famished person suddenly filled with food, dies apoplectic. Drunkards, if they immediately begin a total abstinence from wine, expose themselves to incurable diseases. Sthenia becomes more violent in proportion as it alternates more completely with asthenia, that is to say, in proportion as the habit is more frequently exposed at one time to sthenic affections, and at another to asthenic. By this perpetual irritation the organization becomes so susceptible, that it is very liable to suffer in the highest degree from sthenic diseases. This principle is of the greatest importance for practitioners to be aware of, since it proves that a sudden transition from one extreme to another (as, for example, from cold to heat, taking cold liquors when the body is hot, which often destroys the tone and energy of the stomach,) may lay the foundation of an incurable disease, which sometimes remains long concealed, and then shows itself by the most alarming symptoms.

STICK, the same as baton, an instrument of dignity, which is occasionally carried by persons and officers in high situations particularly by such as are in waiting near the royal person.

STICK, *gold.* An officer of superior rank in the life guards so called, who is in immediate attendance upon the King's person. When his Majesty gives either of his regiments of life-guards to an officer, he presents him with the gold-stick. The colonels of the two regiments wait alternately, month and month. The one on duty is then called gold stick in waiting, and all orders relating to the life-guards are transmitted through him. During that month he commands the brigade, receives all reports, and communicates them to the King. This temporary command of the brigade does not, however, interfere with the promotions that may be going forward, as each colonel lays those of his own particular corps before his Majesty. Formerly the gold stick commanded all guards about his Majesty's person. On levees and drawing-room days he goes into the King's closet for the parole.

STICK, *silver.* The field officer of the life guards, when on duty, is so called. The silver stick is in waiting for a week, during which period all reports are made through him to the gold-stick; and orders from the gold stick pass through him to the brigade. In the absence of the gold-stick on levees and drawing-room days, he goes into the King's closet for the parole.

STIGMA, in botany, the summit of the style, the female organ of generation in plants, which receives the fecundating dust of the tops of the stamina, and transmits its effluvia through the style into the heart of the seed-bud, for the purpose of impregnating the seeds. Most plants have a single stigma, but the lilac has two, the bell flower three, and in others there are four and five. The stigma, when single, generally terminates the style: when there are several, as in the cotton, and most of the liliaceous plants, they are disposed with admirable symmetry along its sides.

STILAGO, in botany, a genus of the Gynandria Triandria class and order. Essential character: calyx one leafed, pitcher-shaped, corolla none: female, stigmas sessile, drupe with a two-celled nut. There

are two species, *viz.* S. bunius, and S. diandra.

STILBE, in botany, a genus of the Polygamia Dioecia class and order. Generic character: hermaphrodite, calyx exterior; perianth three-leaved; leaflets lanceolate, spreading, and mucronate; interior, perianth one-leafed, five-toothed, cartilaginous, to be hardened; corolla one-petalled, funnel-form; stamina, filaments four, awl-shaped, placed on the throat, longer; anthers cordate, obtuse; pistil, germ superior, ovate; style filiform, length of the stamens; stigma acute; pericarpium none, but the interior calyx inclosing, hardened, deciduous; seed one: male on a distinct individual; calyx exterior as in the hermaphrodite; interior none; corolla as in the hermaphrodite; the tube membranaceous; stamina as in the hermaphodite; pericarpium and seed none. There are three species, all natives of the Cape of Good Hope.

STILBITE. This stone was first formed into a distinct species by M. Hauy. Formerly it was considered as a variety of zeolite. The primitive form of its crystals is a rectangular prism, whose bases are rectangles. It crystallizes sometimes in dodecahedrons, consisting of a four-sided prism with hexagonal faces, terminated by four-sided summits, whose faces are oblique parallelograms; sometimes in six-sided prisms, two of whose solid angles are wanting, and a small triangular face in their place. Its texture is foliated. The laminæ are easily separated from each other, and are somewhat flexible. Lustre pearly. Hardness inferior to that of zeolite, which scratches stilbite. Specific gravity 2.5. Colour pearl-white. Powder bright-white, sometimes with a shade of red. This powder, when exposed to the air, cakes and adheres as if it had absorbed water. It causes syrup of violets to assume a green colour. When stilbite is heated in a porcelain crucible, it swells up and assumes the colour and semi-transparency of baked porcelain. By this process it loses 0.185 of its weight. Before the blow-pipe it froths like borax, and then melts into an opaque white coloured enamel. The constituent parts are,

Silica	52.0
Alumina	17.5
Lime	9.0
Water	18.5
	97.0
	3.0
	100

STILLINGIA, in botany, so named in honour of Benjamin Stillingfleet, a genus of the Monoecia Monadelphia class and order. Natural order of Tricoccæ. Euphorbiæ, Jussieu. Essential character: male, calyx hemispherical, many-flowered; corolla tubular, erose: female, calyx one-flowered, inferior; corolla superior; style trifid; capsule tricoccous. There is but one species, *viz.* S. sylvatica; this is a shrub with many upright, round, milky stems, three feet in height, terminated by a spike; two branches commonly spring out at the base of the spike; leaves alternate, petioled, remote, elliptic, serrulate, shining, spreading; spike, or ament, terminating, sessile; flowers small and yellow. It is a native of Carolina in pine woods.

STIMULI, in botany, *stings*, a species of armature, or offensive weapon, with which some plants are armed, as the nettle.

STINK *pot*, an earthen jar charged with powder, grenades, and other materials of an offensive and suffocating smell. It is sometimes used by privateers to annoy an enemy when they mean to board.

STINK *stone*, or STINKSTEIN, in mineralogy, a species of the Talc genus. Is of a wood-brown colour; it occurs massive, and sometimes disseminated; internally, its lustre is from dull to glimmering; when rubbed it emits an urinous smell; but when exposed to heat it loses its colour and smell, and is converted into quick-lime: it effervesces powerfully with acids. It consists of lime and carbonic acid, and a hydro-sulphuret, which is the cause of the smell which it emits when rubbed: it is found principally in beds. The lightest coloured varieties are the softest.

STIPA, in botany, *feather grass*, a genus of the Triandria Digynia class and order. Natural order of Gramina, Gramineæ, or Grasses. Essential character: calyx two-valved, one-flowered; corolla outer valve with a terminating awn, jointed at the base. There are fourteen species, of which we shall notice the S. pennata, soft feather grass: the root is perennial, fibrous, and tufted; culms simple, a foot in height, upright, round, smooth, without knots, clothed entirely with the sheaths of the leaves; leaves rolled in, and bristle-shaped, mucronate, glaucus; sheaths long, and widened; stipule lanceolate, growing to the leaf; panicle simple, few-flowered; flowers large, from four to six; floret awl-shaped, round, nerveless, shorter than the calyx, silky,

bristly at the base; the feathered awns are a beautiful and remarkable feature, at once distinguishing this from all other grasses.

STIPULA, in botany, *straw*, one of the fulcra or supports of plants, defined by Linnæus to be a small leaf, stationed on each side the base of the foot-stalks of the flower and leaves, at their first appearance, for the purpose of support. Linnæus considers the stipulæ as essential characters, in discriminating the species: they exhibit the same variety in form and structure as the leaves, at whose insertion they are frequently placed. The greater number of plants have two stipulæ, one on each side of the foot-stalk. Some stipulæ fall before the leaves, as in the cherry; others are permanent, or continue till the fall of the leaves, as in the rose, raspberry, &c. In most plants, the stipulæ are detached from the stalk; but in the rose, raspberry, &c. they grow close to the plant. By means of the stipulæ, we have frequently capital means of distinguishing the species: as an example, the African and Ethiopian species of honey-flower are essentially distinguished from one another, by the number and situation of the stipulæ, which, in the former, are single, and grow to the stalk; in the latter double, and detached from it.

STOCKING, that part of the clothing of the leg and foot which immediately covers their nudity, and screens them from the cold, &c. Anciently, the only stockings in use were made of cloth, or of milled stuffs sewed together; but since the invention of knitting and weaving stockings of silk, wool, cotton, thread, &c. the use of cloth stockings is quite laid aside. The modern stockings, whether woven or knit, are a kind of plexuses, formed of an infinite number of little knots, called stitches, loops, or meshes, intermingled in one another. Knit stockings are wrought with needles made of polished iron or brass wire, which interweave the threads, and form the meshes the stocking consists of. This operation is called knitting, the invention whereof is commonly attributed to the Scots, on this ground, that the first works of this kind came from thence. It is added, that it was on this account that the company of stocking-knitters, established at Paris in 1527, took for their patron St. Fiacre, who is said to have been the son of a king of Scotland. Woven stockings are ordinarily very fine; they are manufactured on a frame, or machine of polished iron.

The English and French have greatly contested the honour of the invention of the stocking-loom; but we are assured, whatever pretensions the French claim to this invention, that the same was certainly devised by William Lee, of St. John's College, Cambridge, in the year 1589, though it is true, that he first made it public in France, after despairing of success in his own country.

STOCKS, or *Public Funds in England*. By the word stock was originally meant a particular sum of money contributed to the establishing of a fund to enable a company to carry on a certain trade, by means of which the person became a partner in that trade, and received a share of the profit made thereby, in proportion to the money employed. But this term has been extended further, though improperly, to signify any sum of money which has been lent to the government, on condition of receiving a certain interest till the money is repaid, and which makes a part of the national debt. As the security both of the government and of the public companies is esteemed preferable to that of any private person, as the stocks are negotiable and may be sold at any time, and as the interest is always punctually paid when due; so they are thereby enabled to borrow money on a lower interest than what could be obtained from lending it to private persons, where there must be always some danger of losing both principal and interest. But as every capital stock or fund of a company is raised for a particular purpose, and limited by parliament to a certain sum, it necessarily follows, that when that fund is completed, no stock can be bought of the company; though shares already purchased may be transferred from one person to another. This being the case, there is frequently a great disproportion between the original value of the shares and what is given for them when transferred; for if there are more buyers than sellers, a person who is indifferent about selling will not part with his share without a considerable profit to himself; and on the contrary, if many are disposed to sell, and few inclined to buy, the value of such shares will naturally fall in proportion to the impatience of those who want to turn their stock into specie. See FUNDS.

For the sake of those who deal much in the stocks, we shall give a Table showing the comparative value per cent. of the seve-

ral public funds, and the annual interests produced by 100*l.* invested at different prices.

3 per Cts	4 per Cents	5 per Cents	Bank Stock 7 per C	Ind St. 10½ per Cent.	Annual Interest.		
45	60	75	105	157½	6	13	4
45¾	61	76¼	106¾	160⅛	6	11	1
46½	62	77½	108½	162¾	6	9	0
47¼	63	78¾	110¼	165⅜	6	6	11
48	64	80	112	168	6	5	0
48¾	65	81¼	113¾	170⅝	6	3	0
49½	66	82½	115½	173¼	6	1	2
50¼	67	83¾	117¼	175⅞	5	19	4
51	68	85	119	178½	5	17	7
51¾	69	86¼	120¾	181⅛	5	15	11
52½	70	87½	122½	183¾	5	14	3
53¼	71	88¾	124¼	186⅜	5	12	8
54	72	90	126	189	5	11	1
54¾	73	91¼	127¾	191⅝	5	9	6
55½	74	92½	129½	194¼	5	8	1
56¼	75	93¾	131¼	196⅞	5	6	7
57	76	95	133	199½	5	5	3
57¾	77	96¼	134¾	202⅛	5	3	10
58½	78	97½	136½	204¾	5	2	6
59¼	79	98¾	138¼	207⅜	5	1	3
60	80	100	140	210	5	0	0
60¾	81	101¼	141¾	212⅝	4	18	9
61½	82	102½	143½	215¼	4	17	6
62¼	83	103¾	145¼	217⅞	4	16	4
63	84	105	147	220½	4	15	2
63¾	85	106¼	148¾	223⅛	4	14	0
64½	86	107½	150½	225¾	4	13	0
65¼	87	108¾	152¼	228⅜	4	11	11
66	88	110	154	231	4	10	10
66¾	89	111¼	155¾	233⅝	4	9	10
67½	90	112½	157½	236¼	4	8	10
68¼	91	113¾	159¼	238⅞	4	7	10
69	92	115	161	241½	4	6	11
69¾	93	116¼	162¾	244⅛	4	6	0
70½	94	117½	164½	246¾	4	5	1
71¼	95	118¾	166¼	249⅜	4	4	2
72	96	120	168	252	4	3	3
72¾	97	121¼	169¾	254⅝	4	2	5
73½	98	122½	171½	257¼	4	1	7
74¼	99	123¾	173¼	259⅞	4	0	9
75	100	125	175	262½	4	0	0

STOCKS, among ship-carpenters, a frame of timber, and great posts made ashore, to build pinnaces, ketches, boats, and such small craft, and sometimes small frigates. Hence we say, a ship is on the stocks, when she is a building.

STOCKS, a wooden machine to put the legs of offenders in, for the securing of disorderly persons, and by the way of punishment in divers cases, ordained by statute, &c. And it is said, that every vill, within the precinct of a town, is indictable for not having a pair of stocks, and shall forfeit five pounds.

STOEBE, in botany, a genus of the Syngenesia Polygamia Segregata class and order. Natural order of Nucamentaceæ. Corymbiferæ, Jussieu. Essential character: calyx one-flowered; corolla tubular hermaphrodite, receptacle naked, down feathered. There are nine species, chiefly natives of the Cape of Good Hope, they are shrubby plants, resembling heath, at the Cape it forms the principal food of the rhinoceros.

STOICS, a sect of ancient philosophers, the followers of Zeno, thus called from the Greek στοα, which signifies a porch or portico, in regard Zeno used to teach under a portico, or piazza. It was the common fault of the stoics to introduce abundance of subtilty and dryness into their disputations, either by word of mouth, or in writing. They seemed as carefully to avoid all beauty of style, as depravity of morals. Chrysippus, who was one of the stoics, did no great honour to his sect, and could only disgrace it. He believed the gods perishable, and maintained, that they would actually perish in the general conflagration. He allowed the most notorious and abominable incests, and admitted the community of wives amongst sages. See ZENO.

STOKESIA, in botany, so named in honour of Jonathan Stokes, M. D. a genus of the Syngenesia Polygamia Æqualis class and order. Essential character: corollets in the ray funnel-form, longer, irregular; down four-bristled, receptacle naked. There is but one species, *viz.* S. cyanea, blue-flowered stokesia. This plant has a corolla resembling that of the common blue bottle, centaurea cyanus, with almost the calyx of carthamus, to which genus it is allied. It is a native of South Carolina.

STOLE, a sacerdotal ornament, worn by the Romish parish priests over their surplice, as a mark of superiority in their respective churches, and by other priests, over the alb, at celebrating of mass, in which case it goes across the stomach; and by deacons, over the left shoulder, scarf-wise, when the priest reads the gospel for any one, he lays the bottom of his stole on his head. The stole is a broad swath, or slip of stuff hanging from the neck to the feet, with three crosses thereon. The bishops anciently pretended, that the parish-priests were never to appear before them, but in their stole. In Flanders and Italy, they always preach in stoles, it is supposed to be a representation of the extremities of

the long robe wore by the high-priest of the Jews.

STOLE, *groom of the*, the eldest gentleman of his Majesty's bed-chamber, whose office and honour it is to present, and put on, his Majesty's first garment, or shirt, every morning, and to order the things in the chamber.

STOLEN *goods*. To help people to stolen goods for reward, without apprehending the felon, is felony. 4 George I. c. 11. Persons having, or receiving, lead, iron, copper, brass, bell metal, or solder, knowing them to be stolen, shall be transported. 29 George II. c. 30.

STOMACH. See ANATOMY.

STOMOXYS, in natural history, a genus of insects of the order Diptera. Sucker with a single valved sheath, inclosing bristles, each in its proper sheath; two feelers, short, setaceous, of five articulations; antennæ setaceous. There are sixteen species in two sections: A. sheath convolute, and geniculate at the base, with two bristles. B. sheath covering the mouth with five bristles.

STONE (EDMUND), in biography, a distinguished self-taught mathematician, was born in Scotland; but neither the place nor time of his birth are well known, nor have we any memoirs of his life, except a letter from the Chevalier de Ramsay, author of the "Travels of Cyrus," in a letter to Father Castel, a Jesuit at Paris, and published in the "Memoirs de Trevoux," p. 109, as follows: "True genius overcomes all the disadvantages of birth, fortune, and education; of which Mr. Stone is a rare example. Born the son of a gardener of the Duke of Argyle, he arrived at eight years of age before he learned to read. By chance a servant having taught young Stone the letters of the alphabet, there needed nothing more to discover and expand his genius. He applied himself to study, and he arrived at the knowledge of the most sublime geometry and analysis without a master, without a conductor, without any other guide but pure genius.

At eighteen years of age he had made these considerable advances without being known, and without knowing himself the prodigies of his acquisitions. The Duke of Argyle, who joined to his military talents a general knowledge of every science that adorns the mind of a man of his rank, walking one day in his garden, saw lying on the grass a Latin copy of Sir Isaac Newton's celebrated "Principia." He called some one to him to take and carry it back to his library. Our young gardener told him that the book belonged to him. 'To you!' replied the Duke. 'Do you understand geometry, Latin, Newton?' 'I know a little of them,' replied the young man, with an air of simplicity arising from a profound ignorance of his own knowledge and talents. The Duke was surprised; and having a taste for the sciences, he entered into conversation with the young mathematician: he asked him several questions, and was astonished at the force, the accuracy, and the candour of his answers. 'But how,' said the Duke, 'came you by the knowledge of all these things?' Stone replied, 'A servant taught me, ten years since, to read: does one need to know any thing more than the twenty four letters in order to learn every thing else that one wishes?' The Duke's curiosity redoubled; he sat down upon a bank, and requested a detail of all his proceedings in becoming so learned. 'I first learned to read,' said Stone: 'the masons were then at work upon your house: I went near them one day, and I saw that the architect used a rule, compasses, and that he made calculations. I inquired what might be the meaning and use of these things; and I was informed that there was a science called arithmetic: I purchased a book of arithmetic, and I learned it. I was told there was another science called geometry: I bought the books, and I learned geometry. By reading I found that there were good books in these two sciences in Latin: I bought a dictionary, and I learned Latin. I understood also that there were good books of the same kind in French: I bought a dictionary, and I learned French. And this, my Lord, is what I have done: it seems to me that we may learn every thing when we know the twenty-four letters of the alphabet.' This account charmed the Duke. He drew this wonderful genius out of his obscurity, and he provided him with an employment which left him plenty of time to apply himself to the sciences. He discovered in him also the same genius for music, for painting, for architecture, for all the sciences which depend on calculations and proportions.

"I have seen Mr. Stone. He is a man of great simplicity. He is at present sensible of his own knowledge, but he is not puffed up with it. He is possessed with a pure and disinterested love for the mathematics, though he is not solicitous to pass for a mathematician; vanity having no part

in the great labour he sustains to excel in that science. He despises fortune also; and he has solicited me twenty times to request the Duke to give him less employment, which may not be worth the half of that he now has, in order to be more retired, and less taken off from his favourite studies. He discovers sometimes, by methods of his own, truths which others have discovered before him. He is charmed to find on these occasions that he is not a first inventor, and that others have made a greater progress than he thought. Far from being a plagiary, he attributes ingenious solutions, which he gives to certain problems, to the hints which he has found in others, although the connection is but very distant," &c.

Mr. Stone was author and translator of several useful works; *viz.* 1. "A New Mathematical Dictionary," in 1 vol. 8vo. first printed in 1726. 2. "Fluxions," in 1 vol. 8vo. 1730. The Direct Method is a translation from the French of Hospital's "Analyse des Infiniments Petits;" and the Inverse Method was supplied by Stone himself. 3. "The Elements of Euclid," in 2 vols. 8vo. 1731. A neat and useful edition of these Elements, with an account of the life and writings of Euclid, and a defence of his Elements against modern objectors. Beside other smaller works. Stone was a fellow of the Royal Society, and had inserted in the "Philosophical Transactions," (vol. xli. p. 218) an "Account of two species of Lines of the third Order, not mentioned by Sir Isaac Newton or Mr. Stirling."

Stone denotes a certain quantity or weight of some commodities. A stone of beef, at London, is the quantity of eight pounds; in Herefordshire, twelve pounds; in the north, sixteen pounds. A stone of wool (according to the statute of 11 Henry VII.) is to weigh fourteen pounds; yet in some places it is more, in others less; as in Gloucestershire, fifteen pounds; in Herefordshire, twelve pounds. A stone, among horse-coursers, is the weight of fourteen pounds.

STONEHENGE, a celebrated monument of antiquity, stands in the middle of a flat area near the summit of a hill six miles distant from Salisbury. It is inclosed by a circular double bank and ditch, near thirty feet broad, after crossing which we ascend 30 yards before we reach the work. The whole fabric consisted of two circles and two ovals. The outer circle is about 108 feet diameter; consisting, when entire, of 60 stones, 30 uprights and 30 imposts, of which remain only 24 uprights, 17 standing and 7 down, 3½ feet asunder, and 6 imposts. Eleven uprights have their 5 imposts on them by the grand entrance. These stones are from 13 to 20 feet high. The lesser circle is somewhat more than 8 feet from the inside of the outer one, and consisted of 40 lesser stones (the highest 6 feet), of which only 19 remain, and only 11 standing: the walk between these two circles is 300 feet in circumference. The adytum, or cell, is an oval formed of 10 stones (from 16 to 22 feet high) in pairs, with imposts, which Dr. Stukely calls trilithons, and above 30 feet high, rising in height as they go round, and each pair separate, and not connected as the outer pair; the highest 8 feet. Within these are 19 more smaller single stones, of which only six are standing. At the upper end of the adytum is the altar, a large slab of blue coarse marble, 20 inches thick, 16 feet long, and 4 broad; pressed down by the weight of the vast stones that have fallen upon it. The whole number of stones, uprights, imposts, and altar, is exactly 140. The stones are far from being artificial, but were most probably brought from those called the Grey Weathers, on Marlborough Downs, 15 or 16 miles off; and if tried with a tool, they appear of the same hardness, grain, and colour, generally reddish. The heads of oxen, deer, and other beasts, have been found on digging in and about Stonehenge; and human bones in the circumjacent barrows. There are three entrances from the plain to this structure, the most considerable of which is from the north-east, and at each of them were raised, on the outside of the trench, two huge stones, with two smaller within parallel to them.

It has been long a dispute among the learned, by what nation, and for what purpose, these enormous stones were collected and arranged. The first account of this structure we meet with is in Geoffrey of Monmouth, who, in the reign of King Stephen, wrote the history of the Britons in Latin. He tells us, that it was erected by the counsel of Merlin, the British enchanter, at the command of Aurelius Ambrosius, the last British king, in memory of 460 Britons, who were murdered by Hengist the Saxon. The next account is that of Polydore Virgil, who says that the Britons erected this as a sepulchral monument of Aurelius Ambrosius. Others suppose it to have been a sepulchral monument of Boadicea, the famous British

Queen. Inigo Jones is of opinion that it was a Roman temple, from a stone 16 feet long, and 4 broad, placed in an exact position to the eastward altar-fashion. Mr. Charlton attributed it to the Danes, who were two years masters of Wiltshire; a tin tablet, on which were some unknown characters, supposed to be Punic, was dug up near it in the reign of Henry VIII. but is lost: probably that might have given some information respecting its founders. Its common name, Stonehenge, is Saxon, and signifies a "stone gallows," to which those stones having transverse imposts bear some resemblance. It is also called in Welsh *choir gour*, or "the giant's dance." Mr. Grose thinks that Dr. Stukely has completely proved this structure to have been a British temple in which the Druids officiated. He supposes it to have been the metropolitan temple of Great Britain, and translates the words *choir gour*, "the great choir, or temple."

Stone *ware*, a species of pottery, so called from its hardness. See Delft *ware*, Porcelain, and Pottery. Clay is a principal ingredient in pottery of all kinds, which has the property of hardening in the fire, and of receiving and preserving any form into which it is moulded. One kind of clay resists the most violent action of the fire, after being hardened to a certain degree; but is incapable of receiving a sufficient degree of hardness and solidity. A second kind assumes a hardness resembling that of flint, and such a compactness, that vessels made of it have a glossy appearance in their fracture, resembling porcelain. These two species owe their peculiar properties, of resisting heat without melting, to sand, chalk, gypsum, or ferruginous earth, which they contain. A third species of clay begins to harden with a moderate fire, and melts entirely with a strong fire. It is of the second species that stone ware is made. The most famous manufactory of stone ware, as well as of other kinds of pottery, is at Burslem in Staffordshire. This can be traced, with certainty, at least two centuries back; but of its first introduction no tradition remains. In 1686, as we learn from Dr. Plot's "Natural History of Staffordshire," published in that year, only the coarse yellow, red, black, and mottled wares were made in this country; and the only materials employed for them appear to have been the different coloured clays which are found in the neighbourhood, and which form some of the measures or strata of the coal mines. These coarse clays made the body of the ware, and the glaze was produced by powdered lead ore, sprinkled on the pieces before firing, with the addition of a little manganese for some particular colours. The quantity of goods manufactured was at that time so inconsiderable, that the chief sale of them, the Doctor says, was "to poor crate-men, who carried them on their backs all over the country." About the year 1690, two ingenious artisans from Germany, of the name of Eller, settled near Burslem, and carried on a small work for a little time. They brought into this country the method of glazing stone ware, by casting salt into the kiln while it is hot, and some other improvements of less importance; but, finding they could not keep their secrets to themselves, they left the place rather in disgust. From this time, various kinds of stone ware, glazed by the fumes of salt, in the manner above-mentioned, were added to the wares before made. The white kind, which afterwards became, and for many succeeding years continued, the staple branch of pottery, is said to have owed its origin to the following accident. A potter, Mr. Astbury, travelling to London, perceived something amiss with one of his horses' eyes, an hostler at Dunstable said he could soon cure him, and for that purpose put a common black flint stone into the fire. The potter observing it when taken out, to be of a fine white, immediately conceived the idea of improving his ware by the addition of this material to the whitest clay he could procure: accordingly he sent home a quantity of the flint stones of that country, where they are plentiful among the chalk, and by mixing them with tobacco-pipe clay, produced a white stone ware, much superior to any that had been seen before. Some of the other potters soon discovered the source of this superiority, and did not fail to follow his example. For a long time they pounded the flint stones in private rooms, by manual labour in mortars; but many of the poor workmen suffered severely from the dust of the flint getting into their lungs, and producing dreadful coughs, consumptions, and other pulmonary disorders. These disasters, and the increased demand for the flint powder, induced them to try to grind it by mills of various constructions; and this method being found both effectual and safe, has continued in practice ever since. With these improvements, in the beginning of the present century, various articles were pro-

duced for tea and coffee equipages. Soon after, attempts were made to furnish the dinner table also; and, before the middle of the century, utensils for the table were manufactured in quantity, as well for exportation as home consumption. But the salt glaze, the only one then in use for this purpose, is in its own nature so imperfect, and the potters, from an injudicious competition among themselves for cheapness, rather than excellence, had been so inattentive to elegance of form, and neatness of workmanship, that this ware was rejected from the tables of persons of rank, and about the year 1760, a white ware, much more beautiful, and better glazed than ours, began to be imported in considerable quantities from France. This inundation of a foreign manufacture, so much superior to any of our own, must have had very bad effects upon the potteries of this kingdom, if a new one, still more to the public taste, had not appeared soon after. In the year 1763, Mr. Josiah Wedgwood, who had already introduced several improvements into this art, invented a species of earthen ware for the table, quite new in its appearance, covered with a rich and brilliant glaze, bearing sudden alternations of heat and cold, manufactured with ease and expedition, and consequently cheap, and having every requisite for the purpose intended. To this new manufacture the Queen was pleased to give her name and patronage, commanding it to be called Queen's Ware, and honouring the inventor by appointing him her Majesty's potter. The common clay of the country is used for the ordinary sorts; the finer kinds are made of clay from Devonshire and Dorsetshire, chiefly from Biddeford; but the flints from the Thames are all brought rough by sea, either to Liverpool, or Hull, and so by Burton. There is no conjecture formed of the original reason of fixing the manufacture in this spot, except for the convenience of plenty of coals, which abound under all the country. The flints are first ground in mills, and the clay prepared by breaking, washing, and sifting, and then they are mixed in the requisite proportions. The flints are bought first by the people about the country, and by them burnt and ground, and sold to the manufacturers by the peck. The mixture is then laid in large quantities on kilns, to evaporate the moisture; but this is a nice work, as it must not be too dry; next it is beat with large wooden hammers, and then is in order for throwing, and is moulded into the forms in which it is to remain; this is the most difficult work in the whole manufacture. A boy turns a perpendicular wheel, which by means of thongs turns a small horizontal one, just before the thrower, with such velocity, that it twirls round the lump of clay he lays on it into any form he directs it with his fingers.

There were many years ago 300 houses, which were calculated to employ, upon an average, 20 hands each, or 6000 in the whole; but of all the variety of people that work in what may be called the preparation for the employment of the immediate manufacturers, the total number is said to be not much short of 15,000, and it is increasing every day. Large quantities are exported to Germany, Ireland, Holland, Russia, Spain, the East Indies, and much to America; some of the finest sorts to France.

STOP, in music, a word applied by violin and violincello performers to that pressure of the strings by which they are brought into contact with the finger-board, and by which the pitch of the note is determined: a string so pressed is said to be stopped.

STOP, *trumpet*, a reed metallic stop, so called because its tone is imitative of the trumpet. In large organs it generally extends through the whole compass. The mouths of its pipes are not formed like those of the pipes of other stops, but resemble that of the real trumpet. At the bottom of each of the pipes of this stop, in a cavity called the socket, is fixed a brass reed, stopped at the lower end, and open in front; it is furnished with a tongue, or brass spring, which covers the opening, and which, when the wind is impelled into the pipe, is thereby put into a vibratory motion, which produces the imitative tone peculiar to this stop. The trumpet stop is the most powerful in the instrument, and improves the tone as much as it increases the peal of the chorus. Unisonous with the diapasons, it strengthens the foundation, subdues the dissonances of the thirds and fifths of the sesquialtera, and imparts to the compound a richness and grandeur of effect adequate to the sublimest subjects.

STOPPER, in a ship, a piece of cable-laid rope, having a wale-knot at one end, with a laniard fastened to it; and the other end is spliced round a thimble in the ring-bolts upon deck, and at the bits: its use is to stop the cable, that it may not run out too fast; in order to which, they make turns with the laniard about the cable, and

the wale-knot stops it, so that it cannot slip away faster than is necessary.

STORAX. See RESIN.

STORES. If any person who has the charge or custody of any of the King's armour, ordnance, ammunition, shot, powder, or habiliments of war, or of any victuals for victualling the navy, shall, to hinder his Majesty's service, embezzle, purloin, or convey away the same to the value of twenty shillings, or shall steal or embezzle any of his Majesty's sails, cordage, or any other of his naval stores, to the value of twenty shillings, he shall be adjudged guilty of felony without benefit of clergy. 22 Charles II. c. 5. The treasurer, comptroller, surveyor, clerk of the acts, or any commissioner of the navy, may act as justices in causing the offender to be apprehended, committed, and prosecuted for the same. 9 George III. c. 30. If any person shall wilfully and maliciously set on fire, burn, or destroy any of his Majesty's military, naval, or victualling stores, or other ammunition of war, or any place, where any such stores or ammunition shall be kept; he and his abettors shall be guilty of felony without benefit of clergy. 12 George III. c. 24. None but the contractors with the commissioners of the navy shall make any stores of war, naval stores, with the marks commonly used to his Majesty's stores, upon pain of forfeiting two hundred pounds. And persons in whose custody such stores shall be found concealed, are liable to the same penalty. Satute 9 and 10 William III. c. 41.

Justices may mitigate the penalty of concealing stores; statute 9 George I. c. 8. Justices of assize and quarter-sessions may hear and determine offences relating to stores; statute 17 George II. c. 40.

STORK. See ARDEA.

STOWAGE, in naval affairs, the general disposition of the several materials contained in a ship's hold, with regard to their figure, magnitude, or solidity.

STRAKES, in the sea language, signify the uniform ranges of planks on the bottom, decks, and sides of ships, and the garboard strake is that next the keel.

STRAND, signifies any shore of the sea, or bank of a great river: hence an immunity from paying customs on goods or vessels, was anciently expressed by strand and stream.

STRANDED, among seamen, is said of a ship that is driven ashore by a tempest, or runs on ground through ill steerage, and so perishes. Where any vessel is stranded, the justices of the peace are impowered to command the constables near the sea coast, to call assistance, in order to preserve the same, if possible.

STRATA, in natural history, the several beds or layers of different matters whereof the earth is composed. The strata, whereof the earth is composed, are so very different in different countries, that it is impossible to say any thing concerning them, that may be generally applicable: and, indeed the depths to which we can penetrate are so small, that only a very few can be known to us at any rate, those that lie near the centre, or even a great way from it, being for ever hid. One reason why we cannot penetrate to any great depth is, that as we go down, the air becomes foul, loaded with pernicious vapours, inflammable air, fixed air, &c. which destroy the miners, and there is no possibility of going on. In many places, however, these vapours become pernicious much sooner than in others, particularly where sulphureous minerals abound, as in mines of metal, coal, &c. But however great differences there may be among the under strata, the upper one is in some respects the same all over the globe, at least in this respect, that it is fit for the support of vegetables, which the others are not, without long exposure to the air. Properly speaking, indeed, the upper stratum of the earth all round is composed of the pure vegetable mould, though in many places it is mixed with large quantities of other strata, as clay, sand, gravel, &c. and hence proceed the differences of soils, so well known to those who practise agriculture. It has been supposed by some naturalists, that the different strata, of which the earth is composed, were originally formed at the creation, and have continued in a manner immutable ever since: but this cannot possibly have been the case, since we find that many of the strata are strangely intermixed with each other; the bones of animals, both marine and terrestrial, are frequently found at great depths in the earth; beds of oyster shells are found of immense extent in several countries; and concerning these and other shell-fish, it is remarkable, that they are generally found much further from the surface than the bones or teeth either of marine or terrestrial animals.

Neither are the shells or other remains of fish found in those countries adjoining to the seas where they grow naturally, but in the most distant regions. Mr. Whitehurst, in his Inquiry into the Original State and

Formation of the Earth, has given an account of many different kinds of animals, whose shells and other remains, or exuviæ, are found in England; though at present the living animals are not to be found, except in the East or West Indies. Nothing has more perplexed those who undertake to form theories of the earth than these appearances. Some have at once boldly asserted, from these and other phenomena, that the world is eternal. Others have had recourse to the universal deluge. Some, among whom is the Count de Buffon, endeavour to prove that the ocean and dry land are perpetually changing places; that for many ages the highest mountains have been covered with water, in consequence of which the marine animals just mentioned were generated in such vast quantities; that the waters will again cover these mountains, the habitable part of the earth become sea, and the sea become dry land as before, &c. Others have imagined, that they might be occasioned by volcanoes, earthquakes, &c. which confound the different strata, and often intermix the productions of the sea with those of the dry land.

STRATIOTES, in botany, a genus of the Dioecia Dodecandria class and order. Natural order of Palmæ. Hydrocharides, Jussieu. Essential character: spathe two-leaved; perianth superior, trifid; petals three; berry six-celled. There are three species. The stratiotes, water aloe, or water soldier, is a stoloniferous plant, and truly perennial, though each root flowers but once, as in some species of saxifraga, sempervivum, &c. The parent plant, rooted in the mud at the bottom of the ditch, after flowering, sends out buds of leaves at the end of long runners, which rise to the surface, form roots, flower, and then sink to the bottom, where they take hold of the mud, sometimes ripen their seeds, and always become in their turn the parents of another race of young offsets.

STRELITZIA, in botany, so named in honour of Charlotte, Queen of Great Britain, of the family of Mecklenburgh Strelitz, an illustrious patroness of the science of botany, a genus of the Pentandria Monogynia class and order. Natural order of Scitamineæ. Musæ, Jussieu. Essential character: spathes universal and partial; calyx none; corolla three-petalled; nectary three-leaved, involving the gentials; capsule three-celled; cells many-seeded. There are two species, viz. S. reginæ, canna-leaved strelitzia, and S. augusta. These plants are natives of the Cape of Good Hope; they were introduced and named by Sir Joseph Banks.

STRENGTH, in physiology, the same with force.

Men may apply their strength several ways in working a machine. A man of ordinary strength, turning a roller by the handle, can act for a whole day against a resistance equal to thirty pounds weight; and if he works ten hours a day, he will raise a weight of thirty pounds through three feet and a half in a second of time; or if the weight be greater, he will raise it so much less in proportion. But a man may act, for a small time, against a resistance of fifty pounds or more. If two men work at a windlass, or roller, they can more easily draw up seventy pounds, than one man can thirty pounds, provided the elbow of one of the handles be at right angles to that of the other. And with a fly, or heavy wheel, applied to it, a man may do one-third part more work; and for a little while he can act with a force, or overcome a continual resistance, of eighty pounds; and work a whole day when the resistance is but forty pounds. Men used to bear loads, such as porters, will carry, some one hundred and fifty pounds, others two hundred or two hundred and fifty pounds, according to their strength. A man can draw but about seventy or eighty pounds horizontally; for he can but apply about half his weight. If the weight of a man be one hundred and forty pounds, he can act with no greater force in thrusting horizontally, at the height of his shoulders, than twenty seven pounds.

As to horses: a horse is, generally speaking, as strong as five men. A horse will carry two hundred and forty or two hundred and seventy pounds. A horse draws to greatest advantage when the line of direction is a little elevated above the horizon, and the power acts against his breast; and he can draw two hundred pounds for eight hours a day, at two miles and a half an hour. If he draw two hundred and forty pounds, he can work but six hours, and not go quite so fast. And in both cases, if he carries some weight, he will draw the better for it. And this is the weight a horse is supposed to be able to draw over a pulley out of a well. But in a cart, a horse may draw one thousand pounds, or even double that weight, or a ton weight, or more. As the most force a horse can exert, is when he draws a little above the horizontal posi-

tion: so the worst way of applying the strength of a horse, is to make him carry or draw up hill; and three men on a steep hill, carrying each one hundred pounds, will climb up faster than a horse with three hundred pounds. Also, though a horse may draw in a round walk of eighteen feet diameter; yet such a walk should not be less than twenty-five or thirty feet diameter.

STREPTIUM, in botany, a genus of the Didynamia Angiospermia class and order. Essential character: calyx five-toothed; stigma two-lipped; drupe two-lobed, each lobe bipartile. There is but one species, viz. S. asperum, this plant has a woody, perennial, short, irregular stem; branches opposite, exactly four-sided, rough; the height of the whole plant is from two to four feet; leaves opposite, petioled, covered with stiff hooked hairs, from one to three inches long, and from one to two broad; raceme terminating, or in the cleft of the exterior branchlets, erect, long; rachis four-seeded, rough; bractes solitary, one-flowered. Flowers towards the bottom of the raceme, remote; above approximated, small, white. This plant was found by Dr. Roxburgh only in the vicinity of Samulcottah, on the terraces of the old wall of pagodas. It flowers during the wet and cold seasons; when young it is a fair looking plant. The Telingas call it obeera.

STRIKE, a measure of capacity, containing four bushels.

STRIKE, among seamen, is a word variously used: when a ship, in a fight, or on meeting with a ship of war, lets down or lowers her top sails, at least half-mast high, they say she strikes, meaning she yields or submits, or pays respect to the ship of war. Also, when a ship touches ground, in shoal water, they say she strikes. And when a top-mast is to be taken down, the word of command is, strike the top-mast, &c.

STRIX, the *owl*, in natural history, a genus of birds of the order Accipitres. Generic character: the bill hooked, but not furnished with a cere; nostrils oblong, covered with bristly feathers; head, eyes, and ears particularly large; tongue bifid; claws hooked and sharp. Birds of this genus are rapacious. They are seldom seen by day, secluding themselves in the hollows of trees and buildings, and unable, from the particular structure of the eye, to endure the glare of sunshine. When they do appear in the day, they are pursued and persecuted by a variety of small birds, who combine in their expressions of ridicule and aversion, and soon oblige them to recur again to their retreat. During the season of general repose, they are active in quest of food, which in darkness they perceive with facility, and disturb the silence of night by loud and reiterated screams. Their usual prey consists of bats, mice, and small birds. Latham enumerates forty, and Gmelin fifty species. The following are the principal:

S. bubo, or the great-eared owl, is nearly of the size of an eagle, and generally inhabits sequestered and mountainous situations, and the clefts and caverns of rocks, rarely perching upon trees, or seen in the plains. Its nest is nearly three feet in diameter, and its young are seldom more than two, for which it provides extreme plenty and variety. It lives on rats, frogs, and snakes, which it swallows intire, and leverets and rabbits, which it tears to pieces. The hair is thrown up in small balls from the stomach, and many of these may be seen in the places of its favourite residence. It is very rare in England. In Italy it has been trained in the manner of the hawk.

S. otus, or the long-eared owl, is fourteen inches long, and is common both in France and England. It haunts mountainous districts and ruined buildings, and rarely builds a nest, generally occupying that of the buzzard or magpie.

S. brachyotus, or the short-eared owl, is about the size of the last, and is distinguished by the smallness of its upright tufts, or ears, which, after its death, are scarcely perceivable, and when the bird is frighted are considerably depressed; but when it is at ease are clearly perceivable, and in an erect state. Its colour is of a dark brown. It is one of the most beautiful, or least disgusting of the genus; is often seen in small companies, and sometimes in a flock of more than twenty, and lives chiefly on mice, which it watches with all the acuteness and perseverance of a domestic cat.

S. flammea, or the white owl, is fourteen inches long, and is frequently observable in ruined and deserted buildings, though in towns of great population and extent. These it quits by night in search of prey, consisting of mice and birds. It is denominated the screech owl, from the utterance of a screaming and terrific noise, which is peculiar to it, and is distinguished also by a snoring sound during its sleep.

S. passerina, or the little owl, is some

times found in France, and is seldom met with in woods, preferring rocks and decayed buildings. It is distinguished by its activity and clear sightedness during the day, in which it will follow swallows in chase, though rarely, if ever, with success. Small birds in general constitute part of its food, and rats and mice form its principal dependence, but are necessarily torn to pieces by it, as its size is small, and its length does not exceed eight inches.

STROBILUS, in botany, signifies a cone, a species of seed vessel composed of woody scales, which are placed against one another, and split only at top, being fixed below to an axis which occupies the centre of the cone. This botanical term is exemplified in the pine, cypress, fir, and other cone-bearing plants.

STROMATEUS, the *stromat*, in natural history, a genus of fishes of the order Apodes. Generic character: head compressed; teeth in the palate as well as jaws; body oval, broad, and slippery; tail forked. There are three species. S. fixtola, or striped stromat, is an inhabitant of the Mediterranean. Its colour, on the upper parts, is blue, and that of the sides and abdomen of a brilliant silver colour, and its body is transversely marked by serpentine lines of gold; its lips are red, and two lateral lines appear on each side of the back, that nearest the top being curved.

The paru stromat is about as large as a turbot, and is found in the American seas, is of a bright gold colour on the upper, and silver on the lower parts of its body. It is in high estimation for the table.

The ash-coloured stromat is of the length of a foot, inhabits the Indian seas, and is valued as a high delicacy. Its bones are little more than cartilages. The largest fishes of this species are generally deemed the best.

STRONTITES, or STRONTIAN, in mineralogy, is of a green colour; it occurs sometimes massive and sometimes crystallized. This earth was not discovered till about the year 1791 or 1792. Dr. Crawford, indeed, previously to this period, in making some experiments on what he supposed was a carbonate of barytes, and observing a striking difference between this mineral, and the carbonate of barytes which he had been accustomed to employ, conjectured that it might contain a new earth; and he sent a specimen to Mr. Kirwan for the purpose of analyzing it. This conjecture was fully verified by the experiments of Dr. Hope, Mr. Kirwan, and M. Klaproth, who were all engaged in the same analysis nearly about the same time. This earth is found native in combination with carbonic and sulphuric acids. With the former it is found in considerable quantity in the lead mines of Strontian in Argylshire, from which it has derived its name strontites, or strontian, as it is called by others; here it occurs with lead-glance, heavy spar, &c. The nature and properties of this earth have been still further investigated by Pelletier, Fourcroy, and Vauquelin. This earth may be obtained in a state of purity, either by exposing the carbonate of strontites mixed with charcoal powder, to a strong heat, by which the carbonic acid is driven off; or, by dissolving the native salt in nitric acid, and decomposing the nitrate of strontites thus formed, by heat. Strontites obtained by either of these processes, is in small porous fragments of a greenish white colour. It has an acrid, hot, alkaline taste, and converts vegetable blues to green. The specific gravity is from 3.4 to 3.6. Light has no perceptible action upon this earth. When it is exposed to heat, it may be kept a long time, even in a red heat, without undergoing any change, or even the appearance of fusion. By the action of the blow-pipe it is not melted, but is surrounded with a very brilliant white flame. When a little water is thrown on strontites, it exhibits the same appearance as barytes. It is slaked, gives out heat, and then falls to powder. If a greater quantity of water be added, it is dissolved. According to Klaproth it requires 200 parts of water at the ordinary temperature of the atmosphere for its solution. Boiling water dissolves it in greater quantity, and when the solution cools, it affords transparent crystals. These crystals are in the form of rhomboidal plates, or in that of flattened silky needles or compressed prisms. They effloresce in the air, and have an acrid hot taste. The solution of this earth in water is acrid and alkaline, and converts vegetable blues to green. It is soon covered with a pellicle, by absorbing carbonic acid from the atmosphere. Strontites has the property of communicating a purple or red carmine colour to flame. Specimens have been analyzed by various chemists who have obtained different results; according to Klaproth the constituent parts are,

Strontites	69.5
Carbonic acid	30.0
Water	.5
	100

STRONGILUS, in natural history, a genus of the Vermes Intestina class and order. Body round, long, pellucid, glabrous; the fore part globular, truncate, with a circular aperture fringed at the margin, the hind part of the female entire and pointed, of the male dilated into loose, distant, pellucid membranes. There are two species, *viz.* S. equinus, and S. ovinus, the latter is found in the intestines of sheep, the former has an opaque head, and a black intestine, it inhabits the stomach of the horse in great numbers, the male is of a pale yellow, with a fine yellowish membrane covering the intestines, the tail is three-leaved with a small spine or two; female with white filiform vesicles surrounding the intestines.

STROP, in naval affairs, a piece of rope, spliced generally into a circular wreath, and used to surround the body of a block, so that the latter may be hung to any particular situation about the masts, yards, or rigging. Strops are also used to fasten upon any large rope for the purpose of hooking a tackle to the eye of the strop, in order to extend, or pull with redoubled effort upon the same rope.

STROPHE, in ancient poetry, a certain number of verses, including a perfect sense, and making the first part of an ode. What the couplet is in songs, and the stanza in epic poetry, the strophe is in odes.

STRUMPFIA, in botany, so named in memory of Christopher Car. Strumpff, professor of Chemistry and botany at Halle in Magdeburgh, a genus of the Syngenesia Monogamia class and order. Natural order of Compositæ Nucamentaceæ. Essential character: calyx five-toothed, superior; corolla five-petalled; berry one-seeded. There is only one species, *viz.* S. maritima. It is a native of Curaçoa, on rocks by the coast.

STRUTHIO, the *ostrich*, in natural history, a genus of birds of the order Gallinæ. Generic character: the bill straight, depressed, like that of a duck, and rounded at the end; wings short, and unfit for flight; legs naked above the knee; two toes placed forward. Gmelin enumerates four species of this genus, several of which have characters not a little dissimilar in some points, and such as have induced Brisson and Latham to adopt a different arrangement. Having noticed this circumstance, we shall adhere to the Linnæan system. S. camelus, or the black ostrich, is about eight feet long, and when erect, measures about seven feet, and sometimes eight in height. One was exhibited in London in 1750, weighing three hundred pounds. It is found in various parts of Africa, and about the Cape of Good Hope is particularly abundant. In the parts of Asia, near Africa, it is also met with. The idea of these birds burying their eggs in the sand, where the sun brings them to maturity, is contradicted by Kolben, who states, that he has driven the ostrich from its nest innumerable times to procure its eggs for food, adding, that these constitute a most excellent repast, and that one is sufficient for four moderate persons. The ostrich subsists entirely on vegetable productions, but will swallow, occasionally, the most hard and even sharp and pointed substances. Iron, and various other metals, and even glass, have often been found in its stomach, and have unquestionably often proved fatal. It is related upon respectable authority, that an ostrich will carry a man upon its back, and move with very considerable speed, some make the same remark with respect to two men. When unincumbered by any burden, its speed is truly extraordinary, and will exceed, in some instances, the ordinary rapidity of a horse. Ostriches are taken by the natives near the Cape, after a pursuit of two or three days, from mere exhaustion, through which they suffer themselves to be destroyed merely by clubs. Dogs are sometimes employed to hunt them down, followed by men on horseback, who contrive, by means of a long hooked staff, to lay hold of one of the legs of the bird, and thus bring it to the ground. Sometimes they are approached and destroyed by the stratagem of advancing against them in one of the skins of their own species. They are applied to various purposes. Their feathers form an admirable ornament for the ladies; their skins are of sufficient thickness to be manufactured for the purposes of leather; the fat part of their bodies is in high, but perhaps fanciful, estimation in many parts for paralytic and rheumatic complaints, even their eggs are used as goblets, and, if some authors may be credited, young ostriches constitute an agreeable variety for the table. See Aves, Plate XIV. fig. 1.

S. casuarius, or the galeated cassowary, is nearly equal in magnitude to the ostrich, but has a much shorter neck, and therefore is greatly inferior in height. On the top of its head is a species of helmet three inches high and one thick at the base. Each

wing, or what appears as such, is destitute of feathers, and has five bare shafts like those of a porcupine, and the body is covered with loose webbed feathers of a rusty black colour. It is never found beyond the tropical limits, and is no where abundant within them. It is unable to fly, but runs with great speed, and though it lives only on vegetables and fruits, which it is said to swallow unbroken; it is courageous, and even sometimes ferocious, and employs its legs to annoy its adversary by kicking.

C. Nova Hollandia, or the New Holland cassowary, is very similar to the above, but considerably longer.

C. rhea, or the American ostrich, is stated to have been seen by various travellers, but no specimen appears to have been received in this country. It is said to be most numerous in the valleys of the Andes. It subsists partly on fruits, but refuses scarcely any thing that is thrown to it, however inconvenient and pernicious to it. Its favourite food consists of flies, in taking which it is peculiarly active and skilful. Each of its eggs is supposed to contain two pounds of fluid, and it lays between fifty and sixty of these. It calls its young ones by a sound extremely resembling the whistle of a human being, and defends itself by kicking. Its feathers are in high estimation among the Indians for the embellishment of their persons, and are used in forming ornamental coverings for shade.

STRUTHIOLA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Veprecuculæ. Thymeleæ, Jussieu. Essential character: corolla none; calyx tubular, with eight glands at the mouth; berry juiceless, one-seeded. There are five species, all natives of the southern promontory of Africa.

STRYCHNOS, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Luridæ. Apocineæ, Jussieu. Essential character: corolla five-parted; berry one-celled, with a woody rind. There are three species, we shall notice the S. nux vomica, poison nut. It is a native of the East Indies, and is common in almost every part of the coast of Coromandel, flowering during the cold season. The wood is hard and durable, and is used for many purposes by the natives. The root is used to cure intermitting fevers, and the bites of venomous snakes. The seed of the fruit is the officinal nux vomica; it is about an inch broad, and nearly a quarter of an inch thick, covered with a kind of woolly matter; internally it is tough and hard, like horn; to the taste extremely bitter, but having no remarkable smell; it consists chiefly of a gummy matter, the resinous part is very inconsiderable. Nux vomica is reckoned amongst the most powerful poisons of the narcotic kind; it proves fatal to dogs in a very short time. Loureiro relates that a horse died within a quarter of an hour after taking an infusion in wine of the seeds in an half roasted state.

STUARTIA, in botany, a genus of the Monadelphia Polyandria class and order. Natural order of Columniferæ. Tiliaceæ, Jussieu. Essential character: calyx simple; style simple, with a five-cleft stigma; pome juiceless, five-lobed, one-seeded, opening five ways. There are two species, *viz.* S. malacodendron, and S. pentagyna, both natives of Virginia.

STUDDING *sails*, are those which are extended in moderate and steady breezes beyond the skirts of the principal sails, where they appear as wings to the yard-arms.

STURNUS, the *stare*, or *starling*, in natural history, a genus of birds of the order Passeres. Generic character: the bill strait and depressed; nostrils surrounded and protected by a prominent rim; tongue hard and cloven; middle toe joined to the outermost, as far as the first joint. There are seventeen species, of which we shall notice the following.

S. vulgaris, the common starling, weighs about three ounces, and is well known nearly throughout the old world. It builds in rocks, houses, and the hollows of the trunks of trees; but rarely on the branches, unless when availing itself of the deserted nest of some other bird. In winter, starlings are seen in immense multitudes, in company with several other British birds, especially fieldfares and red-wings, and their flight is particularly marked by whirling, and nearly circular, movements, which, while they extremely delay their actual progress, do not absolutely prevent it. They assemble in the mornings to make their excursions for food, which consists of worms and insects, returning to their stations in the evening, and, at both seasons, exhibiting extraordinary tumult and clamour. In confinement, they eat with avidity pieces of raw meat, and, in a state of nature, they are supposed to prefer animal food to vegetable, recurring to the last only when the former is not to

be found. They are extremely docile and mimetic, and may be taught, not merely a great variety of sounds, but even words and phrases.

STYLE, a word of various significations, originally deduced from a kind of bodkin, wherewith the ancients wrote on plates of lead, or on wax, &c. and which is still used to write on ivory leaves, and paper prepared for that purpose, &c.

STYLE, in dialling, denotes the gnomon or cock of a dial, raised on the plane thereof, to project a shadow.

STYLE, in botany, is a part of the pistil of plants, and is of various figures, but always placed on the germen: it gives origin to the stigma.

STYLE, in matters of language, a particular manner of expressing one's thoughts agreeably to the rules of syntax; or, the manner wherein the words, constructed according to the laws of syntax, are arranged among themselves, suitably to the genus of the language.

STYLEPHORUS, in natural history, a genus of fishes of the order Apodes. Generic character: eyes pedunculated, standing on a short, thick cylinder; snout lengthened, directed upwards, retractile towards the head, by means of a membrane; mouth without teeth; three pair of branchiæ beneath the throat; pectoral fins small; dorsal extending completely along the back; caudal short, with spiny rays; body very long and compressed. There is only one species of this wonderful genus, which was first described towards the close of the last century.

S. chordatus is a native of the West India seas, and is nearly three feet in length, including the process at the end of the tail, which is about twenty inches. For a minute description of this singular animal, which was taken swimming near the surface of the water, between Cuba and Martinique, the "Linnæan Transactions;" or "Naturalist's Miscellany," may be consulted with satisfaction.

STYLUS, in botany, the slender part of the pistillum, resembling a pillar, which stands upon the seed-bud, and elevates the stigma. The number of styles, generally speaking, is equal to that of the seed-buds, each seed-bud being furnished with its own particular style. The style either falls with the other parts of the flower, or accompanies the fruit to maturity.

STYPTIC, in pharmacy, medicines which, by their astringent qualities, stop hæmorrhages.

STYRAX, in botany, *storax*, a genus of the Decandria Monogynia class and order. Natural order of Bicornes. Guaiacanæ, Jussieu. Essential character: calyx inferior; corolla funnel-form; drupe two-seeded. There are four species, the most remarkable of which is the S. benzoin, benzoin storax, or benjamin tree, as it is corruptly called, is of quick growth, rising to a considerable height; it is deemed, in Sumatra, which is its native country, to be of sufficient age in six years, or when the trunk is about seven or eight inches in diameter, to afford the benzoin; the bark is then cut through longitudinally, at the beginning of the principal lower branches, from which the drug exudes in a liquid state, and by exposure to the sun and air, soon concretes, when it is scraped off from the bark with a knife or chissel. The quantity which one tree affords, never exceeds three pounds; nor are the trees found to sustain the effects of these annual incisions longer than ten or twelve years. The benzoin which issues first from the wounded bark is the purest, being soft, extremely fragrant, and very white; that which is less esteemed is of a brownish colour, hard, and mixed with various impurities. In Arabia, Persia, and other parts of the East, the coarser sort is consumed in fumigating and perfuming the temples, and in destroying insects.

SUBALTERN, a subordinate officer, or one who discharges his post under the command, and subject to the direction of, another: such are lieutenants, sub-lieutenants, cornets, and ensigns, who serve under the captain; but custom has now appropriated the term to those of much lower rank, as serjeants and the like. We also say, subaltern courts, jurisdictions, &c. such are those of inferior lords, with regard to the lord paramount; hundred courts, with regard to county-courts, &c.

SUBCONTRARY *position*, in geometry, is when two similar triangles are so placed as to have one common angle at the vertex, and yet their bases not parallel.

SUBDUPLE *ratio*, is when any number or quantity is contained in another twice: thus 3 is said to be subduple of 6, as 6 is duple of 3.

SUBDUPLICATE *ratio*, of any two quantities is the ratio of their square roots. This the opposite to the duplicate, which is the ratio of the squares: thus if the quanti-

ties be a and b, the duplicate ratio is $a^2 : b^2$: but the subduplicate ratio is $\sqrt{a} . \sqrt{b}$.

SUBER, or SUBERIC *acid*, in chemistry. The vegetable substance denoted by the name of suber is the epidermis, or outer covering of trees. This substance is analogous to common cork, which is the epidermis of the quercus suber, from which the name of this peculiar vegetable substance is derived. It is a light, soft, elastic substance, is insoluble in water, but readily absorbs this liquid. Common cork is the same substance, having greater density, and accumulated in greater quantity. This matter is very combustible, and burns with a white, vivid flame, leaving behind a very black, light, voluminous, coaly matter. When this matter is distilled, it yields ammonia. When cork is treated with nitric acid, carbonic acid gas and nitrous gas, are evolved. The cork is decomposed, and converted, partly into a yellow, soft, unctuous matter, which swims on the surface, and partly into suberic acid, the nature and properties of which have been already described. See CORK, where will be found an account of the SUBERIC *acid*, SUBERATES, &c.

SUBLIMATION, in chemistry, a process by which certain volatile substances are raised by heat, and again condensed by cold into a solid form. Thus sulphur, exposed to heat in close vessels, is volatilized or sublimed in the form of very white powder, known by the name of "flowers of sulphur." The formation of soot in our chimneys is another instance of sublimation. Benzoin, sublimated, gives flowers of benzoin, a very beautiful substance, which is now more properly called benzoic acid. Sublimation may be performed, in many cases, with common flasks: thus if a small quantity of sal ammoniac is put into a flask, and heat applied to it, the entire salt rises in the form of white smoke, and condenses in the upper part of the flask, in the form of minute crystalline particles, which is a sublimate.

SUBLIME, in discourse, is defined by Boileau, to be something extraordinary and surprising, which strikes the soul, and makes a sentiment or composition ravish and transport.

Longinus makes five sources of the sublime: the first a certain elevation of the mind, which makes us think happily: the second is the pathetic, or that natural vehemence and enthusiasm which strikes and moves us, these two are wholly owing to nature, and must be born with us; whereas the rest depend partly on art: the third is the turning of figures in a certain manner, both those of thoughts and of speech: the fourth, nobleness of expression, which consists of two parts, the choice of words, and the elegant figurative diction: the fifth, which includes, all the rest, is the composition and arrangement of the words in all their magnificence and dignity.

SUBMULTIPLE, in geometry, &c. A submultiple number, or quantity, is that which is contained a certain number of times in another, and which therefore, repeated a certain number of times, becomes exactly equal thereto: thus 3 is a submultiple of 21, in which sense submultiple coincides with an aliquot part.

SUBMULTIPLE *ratio*, is that between the quantity contained and the quantity containing: thus the ratio of 3 to 21 is submultiple. In both cases submultiple is the reverse of multiple, 21, *e. g.* being a multiple of 3, and the ratio of 21 to 3 a multiple ratio.

SUBNORMAL, in geometry, a line which determines the point in the axis of a curve, where a normal, or perpendicular, raised from the point of contact of a tangent to the curve, cuts the axis. Or the subnormal is a line which determines the point wherein the axis is cut by a line falling perpendicularly on the tangent in the point of the contact:

SUBPŒNA, is a writ whereby all persons under the degree of peers are called into Chancery, in such case only where the common law fails, and has made no provision, so as the party who in equity hath wrong, can have no other remedy by the rules and course of common law. It is, therefore, the commencement of a suit in equity. But the peers of the realm in such cases are called by the Lord Chancellor's or Lord Keeper's letters, giving notice of the suit intended against them, and requiring them to appear. There is also a *subpœna ad testificandum*, or a subpœna to give evidence for the summoning of witnesses, as well in Chancery as other courts. There is also a subpœna in the Exchequer, as well in the court of equity there, as in the office of pleas; which latter is a writ that does not require personal service, and is the commencement of a suit at common law there.

SUBSTANTIVE, in grammar, a noun, or name, considered simply and in itself,

without any regard to its qualities, or other accidents, in contradistinction to the noun termed adjective, or that which expresses a certain quality or accident of the noun substantive. See GRAMMAR.

SUBTRACTION. See ARITHMETIC and ALGEBRA.

SUBTANGENT *of a curve*, in the higher geometry, is the line which determines the intersection of the tangent with the axis; or that determines the point wherein the tangent cuts the axis prolonged. In any equation, if the value of the subtangent comes out positive, it is a sign that the points of intersection of the tangent and axis fall on that side of the ordinate where the vertex of the curve lies, as in the parabola and paraboloids: but if it comes out negative, the point of intersection will fall on the contrary side of the ordinate, in respect of the vertex, or beginning of the abscissa; as in the hyperbola and hyperboliform figures. And universally, in all paraboliform and hyperboliform, figures, the subtangent is equal to the exponent of the power of the ordinate, multiplied into the abscissa. See TANGENT.

SUBTENSE, in geometry, the same with the chord of an arch. Hence, the subtense of an angle is a right line supposed to be drawn between the two extremities of the arch that measures that angle.

SUBTRIPLE *Ratio* is when one number, or quantity, is contained in another three times: thus, 2 is said to be subtriple of 6, as 6 is triple of 2.

SUBULARIA, in botany, a genus of the Tetradynamia Siliculosa class and order. Natural order of Siliquosæ or Cruciformes. Cruciferæ, Jussieu. Essential character: silicle entire, ovate; valves ovate, concave, contrary to the partition; style shorter than the silicle. There is only one species, *viz.* S. aquatica, awl-wort, a native of the northern parts of Europe.

SUCCESSOR, in law, is he who follows or comes in another's place. An aggregate corporation, or body composed of many persons, may have a fee-simple estate in succession, without the word successors; and take goods and chattels in action or possession, and they shall go to the successors.

SUCCINATES. See SUCCINIC acid.

SUCCINIC *Acid*, in chemistry, obtained from the decomposition of amber, was formerly called volatile salt of amber, and regarded as an alkaline salt. It was not till towards the end of the seventeeth century, that its acid properties were discovered. See AMBER.

The name of the acid is derived from succinum, the Latin name for amber. It may be obtained by the following process. Introduce a quantity of amber, in powder, into a retort, and let it be covered with dry sand. Adapt a receiver, and distil with a moderate heat in a sand bath. There passes over first a liquid which is of a reddish colour, and afterwards a volatile acid salt, which crystallizes in small, white, or yellowish needles, in the neck of the retort; and if the distillation be continued, a white light oil succeeds, which becomes brown, thick, and viscid. The acid which is obtained in this way is contaminated with the oil; and therefore, to separate this oil, it may be dissolved in hot water, and passed through a filter, on which has been placed a little cotton moistened with oil of amber, which retains the oil, and prevents it from passing through along with the acid. The acid may then be evaporated and crystallized. The crystals are four-sided, rhomboidal, plates, which, if pure, are white. Their taste is sour, and they redden an infusion of litmus. They are soluble in twenty-four parts of cold water, but in much less of hot. They are soluble also in alcohol. This acid is volatile and inflammable: its base is a compound of carbon and hydrogen. It combines with the alkalies, earths, and metallic oxides, forming therewith salts called succinates. Most of these crystallize, as the succinate of potash, soda, lime, &c. but the succinate of magnesia will not crystallize, but by evaporation forms a viscid mass. The metallic succinates are likewise soluble and crystallizable.

SUCCULENTÆ, in botany, the name of the thirteenth order in Linnæus's Fragments of a Natural Method, consisting of flat, fleshy, succulent plants, of which the greater part is ever-green: among these are the cactus, Indian fig; sedum, lesser house-leek; and the saxifrage.

SUCTION, the act of sucking or drawing up a fluid, as air, water, milk, or the like, by means of the mouth and lungs. There are many effects vulgarly attributed to suction, which, in reality, have very different causes. As when any one sucks water, or any other liquor, up through a pipe, it is commonly thought, that by that action the person draws the air up into his mouth, and that the water, which is con-

tiguous to it, follows it by a kind of attraction, as if the air and water hung together; and others fancy, that the air moves into the mouth of the sucker, and the water moves up after the air, to prevent a vacuum, which, they say, nature abhors: whereas the true cause of this phenomenon is only, that the air or atmosphere presses, with its whole weight, uniformly on the surface of the liquor in the vessel; and, consequently, prevents any one part of the water to rise higher than the other there: and if a pipe be put in, of any tolerable large bore, and be open at both ends, the water will rise within the pipe to the same height as without, and, indeed, a little higher, because the pressure of the air within the pipe is a little taken off by bearing against the sides of the pipe. Now when any one applies his mouth to the upper end of the pipe, and sucks, his lips so strongly inclose the pipe, that no air can get between them and it; and, by the voluntary motion of the muscles, the cavity of his thorax, or breast, is opened and enlarged; by which means the air, included there, hath now a much larger space to dilate itself in, and, consequently, cannot press so strongly against the upper end of the pipe, as it did before the cavity of the thorax was so enlarged, and when the weight of the whole atmosphere kept its spring bent. And that weight or pressure being now taken off by the lips of the man that sucks, the equilibrium is destroyed, the air gravitates on the surface of the water, but cannot do so on the upper orifice of the pipe, because the juncture of the lips takes it off; and the spring of the air included in the thorax, being weakened by the dilatation of its cavity, it cannot press so hard against the upper orifice of the pipe, as the water will do against the lower, and, consequently, the water must be forced up into the pipe. It is much the same thing in the suction of a common pump: the sucker being tight, takes off entirely the pressure of the atmosphere on the surface of the water within the barrel of the pump; and, consequently, the atmosphere, by its weight, must force the water up to make the equilibrium.

SUFFERANCE, in law. Tenant at sufferance is he who holdeth over his term at first lawfully granted. A person is tenant at sufferance who continues after his estate is ended, and wrongfully holds against another. Tenants holding over, after determination of their term, and after demand made in writing to deliver possession, are rendered liable to pay double the yearly value. And tenants giving notice of their intention to quit, and not accordingly delivering up the possession at the time in such notice contained, are rendered liable to pay double rent. And it has been held, that under this latter act the notice need not be in writing, and that the landlord may levy his double rent by distress.

SUFFRAGAN, a titular bishop, appointed to aid and assist the bishop of the diocese.

SUGAR exists in every part of plants. It is found in the roots, as those of the carrot and beet root; in the stems, as in the birch, the maple, some palms, and especially the sugar cane; in the leaves, as those of the ash; in the flowers, the fruits, and seeds. But the sugar, which now forms a very extensive article of commerce, and may be considered as a necessary of life, is entirely obtained from the juice of the sugar cane, which is chiefly cultivated in the East and West Indies, by planting cuttings of it in the ground in furrows, dug parallel for that purpose; the cuttings are laid level and even, and are covered up with earth; they soon shoot out new plants from their knots or joints; the ground is to be kept clear, at times, from weeds, and the canes grow quick. When the plants have arrived at their full growth, which, in the West Indies, is in the course of twelve or fourteen months, they are cut down and bruised by means of machinery.

The sugar-mill is composed of three rollers of an equal size, and all armed with iron plates, where the canes are to pass between them; only the middle roller is much higher than the rest, to give the larger sweep to the two poles to which the horses are yoked. This great roller in the middle is furnished with a cog full of teeth, which catch the notches in the two side rollers, and force them about to bruise the canes, which pass quite round the great roller, and come out dry and squeezed from all their juice, which runs into a vessel or back under the mill, and is thence conveyed through a narrow spout into the first boiler.

Sugar mills are, however, differently constructed, but in Plate Sugar Mill are the plan and elevation of one made by Mr. Thomas Rowntree, Blackfriar's Road, Southwark, and sent by him to the West Indies.

A B and D E (fig. 1 and 2) are four ground sills, crossing and halved into each other; on the points of intersection four uprights are framed F F F F, these are con-

nected at top by cross pieces *a a b b*; *e* (in fig. 2.) is another similar framing between the uprights.

Three blocks of wood are fixed crosswise between the beams *e e*, and similar ones across between the upper ones *a a*, to support the bearings for the three rollers *f g h*; these rollers are made of cast iron, and turned in the lathe; they have cog wheels at their upper ends, that they may all turn together; the axis of the middle roller, *g*, is much longer than the two others, and at the upper end is square; a strong wooden cross plate, with iron, *i k*, is fitted on it; some distance above this, it has a square piece of iron, *n*, fixed on its spindle; the long levers, *m m*, by which it is turned, are bolted at their ends to the piece of iron *n*, and to the ends of the wooden cross *i k*; the harness of two mules is made fast to the end of each lever by hooking their traces into the rings at the end of the levers. In this manner the middle roller is turned round, and, by the cogs, the other two by the side of it. The pivots of the rollers are cylindrical, and each turns between six friction rollers, which traverse in a frame made fast to the cross beams, between *a a* and *e e*; the outside of two of these beams slide in rebates cut in the beams *a a* and *e e*, and can be moved up towards the middle roller by wedges, *t t t t*; the weight of each roller is supported on three friction wheels below its lower pivot. The constrution of a set of these friction wheels is shown in figs. 3 and 4. Fig. 4 is an elevation, and fig. 3 a plan: *a* (fig. 4) is the end of the pivot, below this it is turned smaller, nearly to the size of the small circle in fig. 3, so as to leave a square shoulder; *b* is a circular brass plate, fitted upon the small part of the pivot, and resting against the shoulder; *d* is another similar plate, supported by a block of wood, seen in fig. 2, laying on the ground sills D E (fig. 2); the small part of the pivot comes down beyond the plate, *b*, and enters a hole through a thick iron ring *c*, (fig 3); this ring has the three arms projecting from it, which serve as pivots to the three friction rollers *l m n*; it is upon these rollers the upper plate, *b*, and the weight of the great roller, rests; as the pivot, *a*, and the upper plate, *b*, turn round, the three rollers roll round upon the under plate *d*; the iron ring, *c*, has no share in holding the weight, its use is only to keep the three rollers in their places, and in the same manner the small part of the pivot keeps the ring in its place.

A wooden trough is laid upon the beams, *e e* at *w*, to receive the juice expressed from the canes by the rollers; the holes in the bottom of this trough, through which the pivots of the rollers pass, have their orifices above the surface of the liquor in the trough, so that it cannot get down to the friction rollers. A small trough leads from the trough at *w*, and conveys away the liquor, (going under the mule walk), to the boiling house.

The operation of the machine is exceedingly simple: a person presents the ends of the canes to the rollers, *f g*, by their motion the canes are drawn in between them; another person behind bends the ends of the canes as they come through, that they may pass between the other two, *g h*, and thus come out again in the front of the machine, squeezed dry from the juice they before contained. The juice which is collected is conveyed to iron boilers, where it is boiled, with the addition of a small quantity of quick-lime, and the impurities which rise to the surface are scummed off. The boiling is continued till it acquires the consistence of syrup, after which it is put into shallow vessels, where it is allowed to cool and granulate. In general it is afterwards put into hogsheads, in which it is imported to Europe, the bottoms of which are perforated, that the molasses, with which the sugar is mixed may be allowed to drain off. Sometimes it is put into conical earthen vessels, open at both ends, the base of which is covered with moist clay, so that the water filters through the sugar, and carries with it a greater quantity of the molasses and other impurities. The sugar thus treated is called clayed sugar. It is not different from the former, but in being somewhat purer. The addition of quick-lime in the boiling is supposed to take up some vegetable acids which prevent the granulation of the sugar. In this state the sugar is known in commerce by the name of raw or Muscovado sugar. It is still further purified by dissolving it in water, and boiling, when the impurities, which rise to the surface, are again removed; a quantity of lime is also added, and it is clarified with blood. When boiled down to a proper consistency, it is put into unglazed earthen vessels of a conical shape, and inverted, to allow the water from the moist clay, with which the base of the cone is covered, to pass through the sugar, and carry off its impurities.

According to the number of processes to which it has been subjected, it is called sin-

gle or double refined sugar. Sugar in this state is of a white colour: it is well known for its sweet taste; it has little or no smell. It has some degree of transparency when it is crystallized. It is considerably hard, but it is brittle, and may be easily reduced to powder. It is phosphorescent in the dark. When the solution of sugar in water is concentrated, it crystallizes in the form of six-sided prisms, terminated by two-sided summits. The specific gravity of sugar is 1.4. When sugar is exposed to heat, it melts, swells up, becomes of a dark brown or black colour, emits air-bubbles with a peculiar smell, which has been called caromel. If a red heat be applied, it suddenly bursts into flames, with a kind of explosion. It is very soluble in water; at so low a temperature as 48° water dissolves its own weight of sugar. This power increases with the temperature of the water. When water is saturated with sugar, it is called syrup, which by concentration and rest affords crystals. Sugar is soluble in many of the acids. It is decomposed by sulphuric acid; when heat is applied, the acid itself is decomposed, and converted into sulphurous acid; and a great quantity of charcoal is deposited. Nitric acid acts on sugar with considerable violence; an effervescence is produced, nitrous gas is emitted, and the sugar is converted into oxalic and malic acids. Muriatic acid gas is slowly absorbed by sugar, which becomes of a brown colour, and acquires a very strong smell. Sugar is instantly dissolved when it is thrown in the state of powder into liquid oxymuriatic acid; it is converted into malic acid, while the oxymuriatic acid is deprived of its oxygen, and reduced to the state of muriatic acid. Alcohol readily dissolves sugar. One part of sugar is soluble in four of boiling alcohol. Sugar also combines with the oils, and by this means they may be mixed with water. The fixed alkalies combine with sugar, and deprive it of its sweet taste; but by adding sulphuric acid, and precipitating the sulphate which is formed by means of alcohol, the taste is restored. Some of the earths, as lime, combine with sugar, and form similar compounds. The sulphurets and phosphurets of the alkalies, and some of the earths, decompose sugar, and reduce it to a state somewhat similar to gum. By distilling sugar in a retort; the first part of the product is water, nearly in a state of purity. Acetic acid with a little oil next comes over, and afterwards empyreumatic oil. A bulky carbonaceous matter, which sometimes contains a little lime, remains behind. Mr. Cruickshank obtained, by the distillation of 480 grains of pure sugar, by means of a red heat,

	grs.
Acetic acid and oil	270
Charcoal	120
Carbonated hydrogen and carbonic acid gases	90
	480

Sugar, therefore, is composed of oxygen, carbon, and hydrogen.

The proportions of its constituent parts, according to Lavoisier, are the following:

Oxygen	64
Carbon	28
Hydrogen	8
	100

Sugar is also obtained from the juice of the maple tree in North America. See MAPLE.

It has lately been proposed to extract sugar from the root of the beet; and the attempt has been made, even in the large way, by Achard of Berlin. The process which he followed is to boil the roots, cut them into slices, and extract the juice by pressure.

Many other plants also contain sugar, either in the roots, the sap, or the seeds. It exists in wheat, barley, beans, peas, and other leguminous seeds, especially when they are young, in considerable quantity. The uses of sugar are so familiar, that it is scarcely necessary to enumerate them. In most countries, where it can be obtained, it may be considered in some measure as a necessary of life. It contains a great proportion of nutritious matter; animals, when partially supplied with it, become fat and vigorous. It is not changed by the action of the air, so that it may be preserved for any length of time. It is employed to preserve other vegetable matters from putrefaction, and sometimes it is also advantageously applied to a similar purpose, in the preservation of animal substances. It is used likewise in the composition of some varnishes, of ink, and of some pigments, to communicate to them a degree of gloss or lustre.

SUIT, in law, is used in different senses; first, in a suit of law; and is divided into real and personal, and is the same with action real and personal; secondly, suit of court, or suit service, is an attendance that tenants owe to the court of their lord. Thirdly, suit covenant is where the ances-

tor hath covenanted with another to sue to his court. Fourthly, suit custom, when a man and his ancestors have been seized, time out of mind, of his suit. Fifthly, suit real, or regal, when men come to the sheriff's town, or leet. Sixthly, suit signifies the following one in chace, as fresh suit. Lastly, it signifies a petition made to the king, or any great person.

SUKOTYRO, in natural history, a genus of Mammalia. Of the order Bruta. Generic character: horn on each side near the eyes. The only species of this genus is the S. Indicus, first noticed by a Dutch traveller in the seventeenth century, and which has indeed never been described by any other. It is represented as equal in size to a large ox, and possessing the snout of a hog, with ears rough and long, different from the position of those of all other quadrupeds, tail bushy, eyes upright in the head, and next to these having on each side a horn or tusk, approaching in size to that of an elephant. It is said to be a native of Java, and to feed on herbage. As this acount, however, does not appear to have been confirmed by any traveller since Niewhoffe's time, and some of his representations in natural history are extremely slovenly and incorrect, it does not appear a very blameable scepticism to doubt the existence of such an animal. See Mammalia, Plate XX. fig. 4.

SULPHATES, in chemistry, salts formed by the combination of any base with the sulphuric acid; of these we shall notice only the sulphate of soda, known in the shops by the name of Glauber's salts. This salt was discovered by the alchymist Glauber; but since his time it has been largely used in medicine. Chemists have described various modes of obtaining this salt. It exists likewise native in mineral springs, and sometimes it effloresces on the walls of old buildings. Sulphate of soda crystallizes in six-sided prisms, bevelled at the extremities, and longitudinally grooved: its taste is strongly saline and bitter. It is efflorescent; and when exposed to a very dry atmosphere, the surface of the crystals soon becomes white and opaque, and at length they fall into powder: it is soluble in rather less than three times its weight of water at 60°, and in less than its own weight of boiling water. The sulphate of soda, when crystallized, is composed of

Soda	18.48
Sulphuric acid	23.52
Water	58.00
	100.00

SULPHITES, salts formed by the combination of any base with the sulphureous acid. These have always a disagreeable sulphurous taste: they are decomposed by the nitric, muriatic, and some other acids: they are converted into sulphates by exposure to the atmosphere, drawing from it the oxygen. These salts were first noticed and described by Stahl: they are mostly formed artificially, by saturating the alkaline and earthy bases with sulphureous acid.

SULPHUR, an inflammable fossil, of which there are two species; *viz.* common natural sulphur, and volcanic natural sulphur. The colour of the natural sulphur is yellow of different degrees of intensity: it occurs massive, disseminated, and crystallized. The crystals are middle-sized and small, of which the surface is smooth and splendent. Internally it is intermediate between shining and glistening. It is soft and frangible. When placed on inflamed coals, it burns with a bluish flame, and emits a pungent suffocating vapour, and is totally volatilized. It is found in many parts of the world. It occurs commonly in masses, in gypsum, lime-stone, and marl: and in some places with honey-stone, and bituminous wood. It is often found in veins that traverse primitive rocks; in veins of copper pyrites that traverse granite: in Siberia it is found in the gold mines of Catherineburg, and in the lead-glance veins in the Altain mountains. Humboldt mentions a province of Quito, in which he discovered a bed composed of sulphur and quartz, in a mountain of mica slate; he likewise found great quantities of sulphur in primitive porphyry.

The volcanic natural sulphur is yellow, inclining to green: it occurs sometimes corroded; sometimes as a sublimate in flowers. It is glistening, and its lustre is resinous, inclining to adamantine. It occurs only in volcanic countries, where it is found in greater or smaller quantity among the lava. Solfatara, in the vicinity of Vesuvius, is one of the most famous repositories of natural volcanic sulphur, and is there collected in considerable quantities for the purposes of commerce. It is found also in Iceland, in Etna, and in the Lipari island. It occurs likewise in the island of Teneriffe, and in the West India islands; in Java, and the East Indies. Having thus described this substance mineralogically, we turn to it in a chemical view.

Sulphur is a simple undecompounded combustible substance, which is universally diffused in nature; but most commonly in a state of combination with mineral, ve-

getable, or animal matters. It is found in some mineral waters, but in greatest abundance in volcanic countries, where it is a valuable article of commerce. Sulphur, as it is extracted from minerals and purified by art, is a hard, brittle substance, of a yellow colour, which can be easily reduced to powder. It is always opaque, has a lamellated fracture, and becomes electric by friction. The specific gravity, after it is melted, does not exceed 1.99. It has no smell, and very little perceptible taste. When it is rubbed some time, it is volatized, and diffuses a peculiar and slightly fœtid odour, by which it is easily distinguished. It leaves on the skin which has been in contact with it a very strong smell, which remains for some hours. It is insoluble in water. Light has no sensible effect on sulphur. But if a roll of sulphur be held in the hand for a little, it begins to crackle, and at last it breaks to pieces. When a temperature equal to that of boiling water is applied to sulphur, it melts, becomes liquid and transparent, and changes to a brown red colour: but, on cooling, if the fusion is not too long continued, it resumes the yellow colour. If it be permitted to cool slowly, it crystallizes into prismatic needles. The crystals are better formed by pouring out part of the liquid sulphur as soon as the surface has become solid. If the heat be continued, it becomes thick and viscid; and if it be then poured into cold water, it retains its softness, so that it is employed for taking impressions of seals and medals. In this state they are called sulphurs. When sulphur is exposed to heat in close vessels, it is volatized or sublimed in the form of a very fine powder, known under the name of flowers of sulphur. Sulphur enters into combination with oxygen, azote, hydrogen, carbon, and phosphorous. When sulphur is kept some time in fusion in an open vessel, it assumes a red colour, and becomes viscid. After it is cooled, it retains its red colour, which is owing to the combination of oxygen in small proportion with the sulphur. In this state it has been denominated the oxide of sulphur.

According to the experiments of Dr. Thomson, the oxide of sulphur, formed by melting the substance in a deep vessel, is of a dark violet colour, fibrous fracture, and tough consistence; the specific gravity is 2.3. Another oxide was formed by passing a current of oxymuriatic acid gas through flowers of sulphur. When sulphur is burnt in the open air, it emits a pale blue flame, with a great quantity of white smoke. When these fumes are mixed with water, it is found to possess acid properties. This is a combination of sulphur with a greater proportion of oxygen than exists in the oxide, and is called sulphurous acid. But when sulphur is burnt in oxygen gas, a very rapid combustion takes place, with a reddish white flame, and it combines with a greater proportion of oxygen. When the fumes, which are copiously emitted during this combustion, are collected, and mixed with water, it exhibits the properties of an acid, which is the sulphuric acid. Thus it appears, that sulphur combines with oxygen in four different proportions. In two of these, in which the proportions are the smallest, the compounds are denominated oxides; but in the two others, in which the proportion of oxygen is increased, the compounds are acids, the properties of which will be afterwards noticed.

SULPHURETS, in chemistry. Sulphur combines with the fixed alkalies forming compounds called sulphurets. These exist only in a concrete state, as when dissolved in water, a decomposition takes place. We may notice, as an example, the sulphuret of potash, which is formed by exposing to heat in a covered crucible, equal weights of sulphur and the dry concrete alkali. When it has become concrete, it is firm and brittle, and of a reddish brown colour, which, from its resemblance to the liver of an animal, obtained the name of hepar sulphuris, liver of sulphur. This substance, while dry, is inodorous, but when moistened it acquires a fetid smell from the production of sulphuretted hydrogen. It fuses when exposed to a strong heat. A singular property belonging to this substance is, that when fused with some metals, as gold, a combination is formed, which is soluble in water.

SULPHURETTED *hydrogen*, is a compound of sulphur and hydrogen, and it owes its origin to the decomposition of water in the processes by which it is formed. This substance is obtained by various methods, which are detailed by writers on chemistry. It may be had by exposing to a strong heat mixtures of sulphur with vegetable matters, as sugar, oil, &c. The specific gravity is as 1.142 to 1. Its smell is extremely fœtid, approaching to that denominated putrid, the effluvia disengaged in the processes of putrefaction consisting partly of this gas. It extinguishes combustion, and is incapable of supporting animal

life. If sulphuretted hydrogen gas be kindled in contact with the atmospheric air, it burns with a blue lambent flame. When mixed with atmospheric air it does not detonate, and the combustion of its elements is not complete, part of the sulphur being deposited on the sides of the vessel. With oxygen gas it detonates. Sulphuretted hydrogen has a peculiar action on metals, by tarnishing them, and communicating to them shades of yellow, purple, &c. It is possessed of the properties of an acid, and enters into combination with the alkalies, and forms compounds, some of which are crystallizable. It changes vegetable blues to red. It decomposes soap; combines with the metallic oxides, and precipitates sulphur from its combinations with potash or lime.

SULPHURIC *acid*, in chemistry. The name of sulphuric acid is given to the combination of sulphur and of oxygen, with the greatest proportion of the latter. It was formerly called vitriolic acid, because it was obtained from vitriol by distillation, which is a compound of sulphuric acid and an oxide of iron. When it is strongly concentrated, it is called oil of vitriol. If a quantity of flowers of sulphur be exposed to a degree of heat sufficient to inflame it, and if, when it is in a state of ignition, it be introduced into a jar filled with oxygen gas, it burns with great splendour, and emits a great quantity of white fumes. These fumes may be condensed, by pouring a small quantity of water into the jar, and when this is examined, it is found to possess acid properties. This is the sulphuric acid. It is procured, as appears by this experiment, by burning sulphur in oxygen gas.

The process for obtaining sulphuric acid in the large way is the following. A mixture of sulphur and nitre is burnt in leaden chambers. The use of the nitre is to supply a quantity of oxygen for the combustion of the sulphur. There is a little water in the bottom of the vessel, which serves to condense the vapours given out during the combustion.

The acid which is obtained in this way is very weak, for it is diluted with the water in which it was condensed, which water may be separated by distillation. Even after this it is usually contaminated with a little lead from the vessels, some potash, and sometimes nitric and sulphurous acids. To obtain it perfectly pure, the sulphuric acid of commerce must be distilled. This process is conducted by putting a quantity of the acid into a retort, and exposing it to a degree of heat sufficient to make it boil. The beak of the retort is put into a receiver, in which the acid, as it comes over, is condensed. The acid thus purified, is a transparent colourless liquid, of an oily consistence. It has no smell, but a strong acid taste. It destroys all animal and vegetable substances. It reddens all vegetable blues. It always contains water. When this is driven off by a moderate heat, the acid is said to be concentrated. When as much concentrated as possible, the specific gravity is 2, or double that of water; but it can rarely be obtained of greater density than 1.8. The sulphuric acid suffers no change from being exposed to the light. It boils at the temperature of 546°, or, according to Bergman, 540°. When this acid is deprived of its caloric, it is susceptible of congelation, and even of crystallization, in flat, six-sided prisms, terminating in a six-sided pyramid. It crystallizes most readily, when it is neither too much concentrated, nor diluted with water. Of the specific gravity of 1.6 it crystallizes at the temperature of a few degrees below the freezing point of water. Of the specific gravity of 1.8, it resists the greatest degree of cold. Chaptal observed it crystallize at the temperature of 48°, and Mr. Keir found that it froze at 45° of the specific gravity of 1.78. Sulphuric acid has a strong attraction for water.

In some experiments that have been made, sulphuric acid, when exposed to the atmosphere, attracted above six times its weight of water. When four parts of concentrated sulphuric acid, and one part of ice at the temperature of 32°, are mixed together, the moment they come in contact the ice melts, and the temperature rises to 212°. A greater quantity of caloric is given out when the two bodies are mixed together in the liquid state. If four parts of the acid and one of water are suddenly mixed together, the temperature of the mixture rises to about 300°. This extrication of caloric, it is obvious, arises from the sudden condensation of the two liquids, the medium bulk of which is considerably less than the two taken together. So great is the attraction of this acid for water, that the strongest that can be prepared can scarcely be supposed to be entirely free from it. Attempts have been made to determine the proportion of oxygen and sulphur, which enter into the composition of sulphuric acid. According to the experi-

ments of Lavoisier, in which he measured the quantity of oxygen absorbed, by a given weight of sulphur during combustion, the proportions are,

Sulphur	71
Oxygen	29
	100

But other methods have been adopted. These are, by decomposing other substances which contain oxygen, by means of sulphur. According to the experiments of M. Chenevix, conducted in this way, the sulphuric acid consist of.

Sulphur	61. 5
Oxygen	38. 5
	100. 0

Sulphuric acid does not combine with oxygen, nor has it any action with azotic gas. It appears that hydrogen has a greater affinity for oxygen, than the sulphur has, and therefore the sulphuric acid is decomposed by means of hydrogen gas. In the cold there is no action between hydrogen gas and sulphuric acid; but if they are made to pass through a red hot porcelain tube, the acid is decomposed, water is formed, and sulphur is precipitated. When hydrogen gas is employed in a greater proportion than the half of the acid, the superabundant gas dissolves the sulphur, and is disengaged in the form of sulphurated hydrogen gas. Charcoal has no action on sulphuric acid in the cold; but at the boiling temperature, it decomposes it, and converts it into sulphurous acid. If a piece of red-hot charcoal be immersed in a quantity of concentrated sulphuric acid, part of the acid is suddenly disengaged under the form of thick white fumes, accompanied with sulphurous acid gas. The sulphuric acid is decomposed; part of its oxygen is attracted by the charcoal, forming carbonic acid, and thus it is reduced to the lowest proportion of oxygen, in the state of sulphurous acid. A similar effect is produced by phosphorus. Phosphorus, with the assistance of heat, partially decomposes the sulphuric acid, by abstracting part of its oxygen. Phosphoric acid is formed, and sulphurous acid driven off. In the cold, sulphur has no action on sulphuric acid; but, when they are boiled together, the sulphur is partly dissolved in the acid, and converts it into sulphurous acid. The sulphur which has been added combines with the oxygen, which is necessary for the constitution of sulphuric acid, and thus the whole is converted into sulphurous acid. Sulphuric acid combines with alkalies, the earths and the metals forming salts; which in the present language of chemistry are denominated sulphates. This acid is employed in great quantity in many arts and manufactures. It is employed also in medicine and pharmacy; the preparation of it, therefore, has long been an object of considerable importance.

SULPHUROUS *acid*, was formerly called spirit of sulphur, and volatile sulphurous acid. It was not till the year 1774 that its nature and composition were discovered by the labours of Priestley and Lavoisier. Berthollet afterwards investigated the formation, decomposition, combinations, and uses of this acid. Fourcroy and Vauquelin also have examined many of its properties, especially the saline compounds which it forms, so that now its properties are well known. The sulphurous acid exists in nature in great abundance, and particularly in the neighbourhood of volcanoes. It is disengaged from some lavas in a state of fusion, and from the soil which is impregnated with sulphur, when a sufficient degree of heat is applied. It was by the vapours of sulphurous acid that Pliny the naturalist was suffocated in the eruption of Mount Vesuvius, which destroyed Herculaneum, in the 79th year before the Christian æra. When sulphur is burnt in the open air, the fumes that are generated by this slow combustion, are sulphurous acid. It was in this way that this acid was formerly obtained. The method of procuring it, which is now followed, is to decompose the sulphuric acid by means of any substance which deprives it of part of its oxygen. If one part of mercury and two parts of concentrated sulphuric acid be exposed to heat in a glass retort, the mixture effervesces, and a gas is disengaged, which may be collected in jars over mercury. In this process the mercury attracts part of the oxygen of the sulphuric acid, and leaves behind that portion which constitutes the sulphurous acid. Sulphurous acid thus obtained is in the state of gas, and it is an elastic, invisible and colourless fluid, like common air. It is rather more than double the weight of atmospheric air. It reddens vegetable blues, and then destroys the greater number of them. It is on account of this property that the fumes of sulphur are employed to remove the stains of fruit from linen, and

that the sulphurous acid is often used in bleaching. When the sulphurous acid is in the form of gas, it does not readily combine with oxygen. In its fluid form it unites more readily, and is converted into sulphuric acid. In making a mixture of sulphurous acid gas and oxygen gas pass through a red-hot tube, they combine together, and are converted into sulphuric acid. There seems to be no action between sulphurous acid and azotic gas. Water has a strong attraction for sulphurous acid gas. A piece of ice brought in contact with it, is immediately melted without any perceptible change of temperature. When water is saturated with this gas, it is known by the name of sulphurous acid, or liquid sulphurous acid. The specific gravity is 1.04. At the temperature of 43° water combines with one-third of its weight of sulphurous acid gas; but as the temperature increases, it absorbs it in smaller proportion. It freezes at a temperature a few degrees below 32°, and it passes into the solid state without parting with any of its acid. The liquid sulphurous acid has the smell, taste, and other properties of the gas, and particularly that of destroying vegetable colours. When exposed to the atmosphere, it gradually absorbs oxygen, and passes into the state of sulphuric acid. This change goes on more rapidly when it is diluted with water, and agitated in contact with the air. The sulphuric acid separates the sulphurous acid in the gaseous form from its combinations, and even from water. Concentrated sulphuric acid absorbs this gas, which imparts to it a yellowish brown colour and renders it pungent and fuming. The two acids strongly attract each other, so that when they are exposed to the action of heat, the first vapour which rises crystallizes in long, white, needle-shaped prisms. This is a compound of the two acids. It smokes in the air; dissolves with effervescence in it, and when thrown into water produces a hissing noise, like a red-hot iron. Sulphurous acid is very much employed in the arts, and sometimes in medicine. In the state of gas it is used for the bleaching of silk and wool, by extracting the colouring matter. It removes also the stains arising from vegetable juices, and spots of iron from linen. According to Fourcroy, 100 parts of this acid are composed of

Sulphur	85
Oxygen	15
	100

But according to the analysis of Dr. Thomson,

Sulphur	68
Oxygen	32
	100

The compound salts formed by this acid are denominated sulphites.

SUM, in mathematics, signifies the quantity that arises from the addition of two or more magnitudes, numbers, or quantities together. The sum of an equation is, when the absolute number being brought over to the other side of the equation, with a contrary sign, the whole becomes equal to 0: thus, the sum of the equation $x^3 - 12x^2 + 41x = 42$, is $x^3 - 12x^2 + 41x - 42 = 0$.

SUMMER, in architecture, is a large stone, the first that is laid over columns and pilasters, in beginning to make a cross vault.

SUMMER, in carpentry, is a large piece of timber, which being supported on two stone piers, or posts, serves as a lintel to a door, window, &c.

SUN, in astronomy, the most conspicuous of the heavenly bodies, which occupies the centre of the system, which comprehends the earth, the primary and secondary planets, and comets. The sun is the magnificent luminary which enlightens these worlds, and by its presence constitutes day. We have referred to this article from the fixed STARS, because the sun agrees with them in several particulars, as in the property of emitting light continually, and in retaining constantly its relative situation with but little variation: they may have probably many other properties in common. The sun is, therefore, justly considered as a fixed star comparatively near us; and the stars as suns at immense distances from our earth; and we reasonably infer, from the same analogy, that the stars are possessed of gravitation, and of the other general properties of matter; they are supposed to emit heat as well as light; and it has been conjectured that they serve to cherish the inhabitants of a multitude of planetary bodies revolving round them.

In a paper on the "Constructions of the Heavens," Dr. Herschel says, it is very probable, that the great stratum called the milky way is that in which the sun is placed, though perhaps not in the centre of its thickness, but not far from the place where some smaller stratum branches from it. Such a supposition will satisfactorily, and

with great simplicity, account for all the phenomena of the milky way, which, according to this hypothesis, is no other than the appearance of the projection of the stars contained in this stratum, and its secondary branch. See GALAXY.

In another paper on the same subject, he says, that the milky way is a most extensive stratum of stars of various sizes admits no longer of the least doubt; and that our sun is actually one of the heavenly bodies belonging to it is as evident.

We will now, says the Doctor, retreat to our own retired station in one of the planets attending a star in the great combination, with numberless others; and in order to investigate what will be the appearances from this contracted situation let us begin with the naked eye. The stars of the first magnitude, being in all probability the nearest, will furnish us with a step to begin our scale; setting off, therefore, with the distance of Sirius or Arcturus, for instance, as unity, we will at present suppose, that those of the second magnitude are at double, and those of the third at treble the distance, and so forth. Taking it, then, for granted, that a star of the seventh magnitude is about seven times as far from us as one of the first, it follows that an observer, who is enclosed in a globular cluster of stars, and not far from the centre, will never be able, with the naked eye, to see to the end of it: for since, according to the above estimations, he can only extend his view about seven times the distance of Sirius, it cannot be expected that his eyes should reach the borders of a cluster, which has, perhaps, not less than fifty stars in depth every where around him. The whole universe, therefore, to him, will be comprised in a set of constellations, richly ornamented with scattered stars of all sizes. Or if the united brightness of a neighbouring cluster of stars should, in a remarkably clear night, reach his sight, it will put on the appearance of a small, faint, nebulous cloud, not to be perceived without the greatest attention. Allowing him the use of a common telescope, he begins to suspect that all the milkyness of the bright path which surrounds the sphere may be owing to stars. By increasing his power of vision, he becomes certain that the milky way is, indeed, no other than a collection of very small stars, and the nebulæ nothing but clusters of stars.

Dr. Herschel then solves a general problem for computing the length of the visual ray: that of the telescope, which he uses, will reach to stars 497 times the distance of Sirius. Now, according to the Doctor's reasoning, Sirius cannot be nearer than $100{,}000 \times 194{,}000{,}000$ miles, therefore his telescope will, at least, reach to $100{,}000 \times 194{,}000{,}000 \times 497$ miles. And Dr. Herschel says, that in the most crowded part of the milky way, he has had fields of view that contained no less than 588 stars, and these were continued for many minutes, so that, in a quarter of an hour, he has seen 116,000 stars pass through the field view of a telescope of only 15′ aperture: and at another time, in 41 minutes, he saw 258,000 stars pass through the field of his telescope. Every improvement in his telescopes has discovered stars not seen before, so that there appears no bounds to their number, or to the extent of the universe.

The sun, like many other stars, has probably a progressive motion, directed towards the constellation Hercules. Dr. Herschel, on this subject, observes that the apparent proper motions of 44 stars out of 56 are nearly in the direction which would be the result of such a real motion of the solar system; and that the bright stars Arcturus and Sirius, which are probably the nearest to us, have, as they ought, according to this theory, the greatest apparent motions. Again, the star Castor, appears when viewed with a telescope, to consist of two stars, of nearly equal magnitude; and though they have both an apparent motion they have never been found to change their distance with respect to one another a single second, a circumstance which is easily understood if both their apparent motions are supposed to arise from the real motion of the sun.

The sun revolves on his axis in $25^d\ 10^h$ with respect to the fixed stars; this axis is directed towards a point about half way between the pole star and Lyra, the plane of the rotation being inclined a little more than 7° to that in which the earth revolves. The direction of this motion is from west to east. All the rotations of the different bodies which compose the solar system as far as they have been ascertained, are in the same direction, and likewise all their revolutions, excepting those of some of the comets, and those of some of the satellites of the Herschel planet.

The time and the direction of the sun's rotation are ascertained by the change of the situation of the spots, which are usually visible on his disc, and which some astronomers supposed to be elevations, and

others to be excavations in the luminous matter covering the sun's surface. These spots are frequently observed to appear and disappear, and they are in the mean time liable to great variations, though they are generally found about the same points of the sun's surface. M. Lalande supposes them to be parts of the solid body of the sun, which by some agitations of the luminous ocean, with which he conceives the sun to be surrounded, are left nearly or entirely bare. Dr. Wilson and Dr. Herschel are disposed to consider this ocean as consisting rather of a flame than of a liquid substance; and Dr. Herschel, in an ingenious paper, attributes the spots to the emission of an æriform fluid, not yet in combustion, which displaces the general luminous atmosphere, and which is afterwards to serve as fuel for supporting the process; hence he supposes the appearance of copious spots to be indicative of the approach of warm seasons on the surface of the earth, a theory which he has attempted to maintain by historical evidence. The exterior luminous atmosphere has an appearance somewhat mottled, some parts of it, appearing brighter than others, have been called faculæ, but Dr. Herschel distinguishes them by the names of ridges and nodules. The spots are usually surrounded by margins less dark than themselves, which are called shallows, and which are considered as parts of an inferior stratum, consisting of opaque clouds, capable of protecting the immediate surface of the sun from the excessive heat produced by combustion in the superior stratum, and perhaps rendering it habitable to animated beings.

To which Dr. Young replies, if we inquire into the intensity of the heat which must necessarily exist wherever this combustion is performed, we shall soon be convinced that no clouds, however dense, could impede its rapid transmission to the parts below. Besides the diameter of the sun is 111 times as great as that of the earth; and at its surface, a heavy body would fall through no less than 450 feet in a single second; so that if every other circumstance permitted human beings to reside on it, their own weight would present an insuperable difficulty, since it would become thirty times as great as upon the surface of the earth, and a man of moderate size would weigh above two tons.

Dr. Herschel, in another paper, supposes, that the spots in the sun are mountains on its surface, which, considering the great attraction exerted by the sun upon bodies placed at its surface, and the slow revolution it has about its axis, he thinks may be more than 300 miles high, and yet stand very firmly. He says, that in August, 1792, he examined the sun with several powers from 90 to 500. And it evidently appeared, that the black spots are the opaque ground or body of the sun; and that the luminous part is an atmosphere, which being intercepted or broken, gives us a glimpse of the sun itself. Hence he concludes, that the sun has a very extensive atmosphere, which consists of elastic fluids that are more or less lucid and transparent; and of which the lucid ones furnish us with light. This atmosphere, he thinks, is not less than 1843, nor more than 2765 miles in height; and he supposes that the density of the luminous solar clouds need not be exceedingly more than that of our aurora borealis, in order to produce the effects with which we are acquainted.

The sun, then, appears to be a very eminent, large, and lucid planet, evidently the first and only primary one belonging to our system. Its similarity to the other globes of the solar system, with regard to its solidity; its atmosphere; its surface diversified with mountains and vallies; its rotation on its axis; and the fall of heavy bodies on its surface; leads us to suppose that it is most probably inhabited, like the rest of the planets, by beings whose organs are adapted to the peculiar circumstances of that vast globe. If it be objected, that from the effects produced at the distance of 95,000,000 miles, we may infer, that every thing must be scorched up at its surface. We reply, that there are many facts in natural philosophy which show that heat is produced by the sun's rays only when they act on a calorific medium: they are the cause of the production of heat by uniting with the matter of fire which is contained in the substances that are heated; as the collision of the flint and steel will inflame a magazine of gunpowder, by putting all the latent fire which it contains into action. On the tops of mountains of sufficient height, at the altitude where clouds can seldom reach to shelter them from the direct rays of the sun, we always find regions of ice and snow. Now, if the solar rays themselves conveyed all the heat we find on this globe, it ought to be hottest where their course is the least interrupted. Again, our aëronauts all confirm the coldness of the upper regions of the atmosphere; and since, therefore, even on

our earth the heat of the situation depends upon the readiness of the medium to yield to the impression of the solar rays, we have only to admit, that on the sun itself, the elastic fluids composing its atmosphere, and the matter on its surface, are of such a nature as not to be capable of any extensive affection of its own rays; and this seems to be proved by the copious emission of them; for if the elastic fluids of the atmosphere, or of the matter contained on the surface of the sun, were of such a nature as to admit of an easy chemical combination with its rays, their emission would be very much impeded. Another well known fact is, that the solar focus of the largest lens thrown into the air, will occasion no sensible heat in the place where it has been kept for a considerable time, although its power of exciting combustion, when proper bodies are exposed, should be sufficient to fuse the most refractory substances.

It is by analogical reasoning that we consider the moon as inhabited. For it is a secondary planet of considerable size, its surface is diversified, like that of the earth, with hills and vallies. Its situation with respect to the sun, is much like that of the earth; and by a rotation on its axis, it enjoys an agreeable variety of seasons, and of day and night. To the moon our globe would appear a capital satellite, undergoing the same changes of illumination as the moon does to the earth. The sun, planets, and the starry constellations of the heavens, will rise and set there as they do here: and heavy bodies will fall on the moon as they do on the earth. There seems, then, only to be wanting, in order to complete the analogy, that it should be inhabited like the earth. It may be objected, that, in the moon, there are no large seas; and its atmosphere (the existence of which is doubted by many) is extremely rare, and unfit for the purposes of animal life; that its climates, its seasons, and the length of its days and nights, totally differ from ours; that without dense clouds, which the moon has not, there can be no rain, perhaps no rivers and lakes. In answer to this, it may be observed, that the very difference between the two planets strengthens the argument. We find even on our own globe, that there is a most striking dissimilarity in the situation of the creatures that live upon it. While man walks on the ground, the birds fly in the air, and the fishes swim in the water. We cannot surely object to the conveniencies afforded by the moon, if those that are to inhabit its regions are fitted to their conditions as well as we on this globe of ours. The analogy already mentioned establishes a high probability that the moon is inhabited.

Suppose, then, an inhabitant of the moon, who has not properly considered such analogical reasonings as might induce him to surmise that our earth is inhabited, were to give it as his opinion, that the use of that great body, which he sees in his neighbourhood, is to carry about his little globe, in order that it may be properly exposed to the light of the sun, so as to enjoy an agreeable and useful variety of illumination, as well as to give it light by reflection, when direct light cannot be had. Should we not condemn his ignorance and want of reflection? The earth, it is true, performs those offices which have been named, for the inhabitants of the moon, but we know that it also affords magnificent dwelling-places to numberless intelligent beings. From experience, therefore, we affirm, that the performance of the most salutary offices to inferior planets is not inconsistent with the dignity of superior purposes; and in consequence of such analogical reasonings, assisted by telescopic views, which plainly favour the same opinion, we do not hesitate to admit that the sun is richly stored with inhabitants.

This way of considering the sun is of the utmost importance in its consequences. That stars are suns can hardly admit of a doubt. Their immense distance would effectually exclude them from our view, if their light were not of the solar kind. Besides, the analogy may be traced much further: the sun turns on its axis; so does the star Algol; so do the stars called β Lyræ, δ Cephei, η Antinoi, ο Ceti, and many more, most probably all. Now from what other cause can we, with so much probability, account for their periodical changes? Again, our sun's spots are changeable; so are the spots on the star ο Ceti. But if stars are suns, and suns are inhabitable, we see at once what an extensive field for animation opens to our view.

It is true, that analogy may induce us to conclude, that since stars appear to be suns, and suns, according to the common opinion, are bodies that serve to enlighten, warm, and sustain a system of planets, we may have an idea of numberless globes that serve for the habitation of living creatures. But if these suns themselves are primary planets, we may see some thousands of

them with the naked eyes, and millions with the help of telescopes; and, at the same time, the same analogical reasoning still remains in full force with regard to the planets which these suns may support. See Philosophical Transactions, and Young's Natural Philosophy.

We shall conclude this article, with some particulars respecting the sun, by Sir Isaac Newton. 1. That the density of the sun's heat, which is proportional to his light, is 7 times as great in Mercury as with us, and that water there would be all carried off in the shape of steam, for, he found, by experiments with the thermometer, that a heat seven times greater than that of the sun's beams in summer will serve to make water boil. 2. That the quantity of matter in the sun is to that in Jupiter nearly as 1100 to 1, and that the distance of that planet from the sun is in the same ratio to the sun's semidiameter; consequently, that the centre of gravity of the sun and Jupiter is nearly in the superficies of the sun. 3. That the quantity of matter in the sun is to that in Saturn as 2360 to 1, and that the distance of Saturn from the sun is in a ratio but little less than that of the sun's semidiameter. And hence the common centre of gravity of Saturn and the sun is a little within the sun. 4. By the same method of calculation it will be found, that the common centre of gravity of all the planets cannot be more than the length of the solar diameter distant from the centre of the sun. 5. The sun's diameter is equal to 100 diameters of the earth, and therefore its magnitude must exceed that of the earth one million of times. 6. If 360 degrees (the whole ecliptic) be divided by the quantity of the solar year, it will give 59′ 8″, which therefore is the medium quantity of the sun's apparent daily motion; hence his horary motion is equal to 2′ 27″. By this method the tables of the sun's mean motion are constructed as found in astronomical books.

SUPERCARGO, a person employed by merchants to go a voyage, and oversee their cargo or lading, and dispose of it to the best advantage.

SUPERFICIES, or SURFACE, in geometry, a magnitude considered as having two dimensions; or extended in length and breadth, but without thickness or depth. In bodies, the superficies is all that presents itself to the eye. A superficies is chiefly considered as the external part of a solid. When we speak of a surface simply, and without any regard to body, we usually call it figure. The several kinds of superficies are as follow: rectilinear superficies, that comprehended between right lines; curvilinear superficies, that comprehended between curve lines; plane superficies, is that which has no inequality, but lies evenly between its boundary lines; convex superficies, is the exterior part of a spherical, or spheroidical body; and a concave superficies, is the internal part of an orbicular or spheroidical body.

The measure or quantity of a superficies, or surface, is called the area thereof.

The finding of this measure, or area, is called the quadrature thereof.

To measure the surfaces of the several kinds of bodies, as spheres, cubes, paralellopipeds, pyramids, prisms, cones, &c.

SUPERFICIES, *line of*, a line usually found on the sector, and Gunter's scale, the description and use whereof, see under SECTOR and GUNTER's *scale*.

SUPERLATIVE, in grammar, one of the three degrees of comparison, being that inflection of nouns-adjective that serves to augment and heighten their signification, and shows the quality of the thing denoted to be in the highest degree.

SUPERNUMERARY, something over and above a fixed number. In several of the offices are supernumerary clerks, to be ready on extraordinary occasions. There are also supernumerary surveyors of the excise, to be ready to supply vacancies when they fall; these have but half pay.

SUPERSEDEAS, a writ that lies in a great many cases, and signifies, in general, a command to stay proceedings, on good cause shown, which ought otherwise to proceed. By a supersedeas, the doing of a thing which might otherwise have been lawfully done, is prevented; or a thing that has been done, is (notwithstanding it was done in a due course of law) thereby made void. A supersedeas is either expressed or implied; an express supersedeas is sometimes by writ, sometimes without a writ; where it is by writ, some person to whom the writ is directed, is thereby commanded to forbear the doing something therein mentioned; or if the thing has been already done, to revoke, as that can be done, the act.

A person is superseded out of prison, when, by the practice of the court, the plaintiff has omitted to proceed in due time against him.

SUPPLEMENT *of an arch*, in geometry, or trigonometry, is the number of degrees that it wants of being an intire semicircle; as a complement, signifies what an arch wants of being a quadrant.

SUPPORTED, in heraldry, a term applied to the uppermost quarters of a shield when divided into several quarters, these seeming as it were supported or sustained by those below. The chief is said to be supported when it is of two colours, and the upper colour takes up two-thirds of it. In this case it is supported by the colour underneath.

SUPPORTERS, in heraldry, figures in an achievement placed by the side of the shield, and seeming to support or hold up the same. Supporters are chiefly figures of beasts: figures of human creatures, for the like purpose, are properly called tenants. Some make another difference between tenant and supporter: when the shield is borne by a single animal, it is called tenant; when by two, they are called supporters. The figures of things inanimate sometimes placed aside of escutcheons, but not touching or seeming to bear them, though sometimes called supporters, are more properly cotises. The supporters of the British arms are a lion and an unicorn. In England, none under the degree of a banneret are allowed supporters, which are restrained to those called the high nobility. The Germans permit none but princes and noblemen of rank to bear them; but among the French formerly the use of them was more promiscuous.

SUPPRESSION, in grammar and rhetoric, denotes an omission of certain words in a sentence, which yet are necessary to full and perfect construction: as, "I come from my father's;" that is, "from my father's house." Suppression is a figure of speech very frequent in our language, chiefly used for brevity and elegance. Some rules relating thereto are as follow: 1. Whenever a word comes to be repeated in a sentence oftener than once, it is to be suppressed. Thus we say, "This is my master's horse," not "This horse is my master's horse." 2. Words that are necessarily supplied may be suppressed: and, 3. All words that use and custom suppress in other languages, are also to be suppressed in English, unless there be particular reasons for the contrary.

Suppression is also a figure in speech whereby a person in rage, or other disturbance of mind, speaks not out all he means, but suddenly breaks off his discourse. Thus the gentleman in Terence, extremely incensed against his adversary, accosts him with this abrupt saying, "Thou of all." The excess of his indignation and rage choaked the passage of his voice, and would not suffer him to utter the rest. But in these cases, though the discourse is not complete, the meaning is readily understood, and the evidence of the thought easily supplies the defect of words. Suppression sometimes proceeds from modesty and fear of uttering any word of ill and offensive sound.

SURD, in arithmetic and algebra, denotes any number or quantity that is incommensurable to unity: otherwise called an irrational number or quantity.

The square roots of all numbers, except 1, 4, 9, 16, 25, 36, 49, 64, 81, 100, 121, 144, &c. (which are the squares of the integer numbers, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, &c.) are incommensurables: and after the same manner the cube roots of all numbers but of the cubes of 1, 2, 3, 4, 5, 6, &c. are incommensurables: and quantities that are to one another in the proportion of such numbers, must also have their square-roots, or cube roots, incommensurable.

The roots, therefore, of such numbers, being incommensurable, are expressed by placing the proper radical sign over them: thus $\sqrt[2]{2}$, $\sqrt[2]{3}$, $\sqrt[2]{5}$, $\sqrt[2]{6}$, &c. express numbers incommensurable with unity. However, though these numbers are incommensurable themselves with unity, yet they are commensurable in power with it; because their powers are integers, that is, multiples of unity. They may also be commensurable sometimes with one another, as the $\sqrt[2]{8}$ and $\sqrt[2]{2}$; because they are to one another as 2 to 1: and when they have a common measure, as $\sqrt[2]{2}$ is the common measure of both; then their ratio is reduced to an expression in the least terms, as that of commensurable quantities, by dividing them by their greatest common measure. This common measure is found as in commensurable quantities, only the root of the common measure is to be made their common divisor: thus $\frac{\sqrt{12}}{\sqrt{3}} = \sqrt{4} = 2$, and $\frac{\sqrt{18a}}{\sqrt{2}} = 3\sqrt{a}$.

A rational quantity may be reduced to the form of any given surd, by raising the quantity to the power that is denominated by the name of the surd, and then setting the radical sign over it: thus $a = \sqrt[2]{a^2} =$

$\sqrt[3]{a^3} = \sqrt[4]{a^4} = \sqrt[5]{a^5} = \sqrt[n]{a^n}$, and $4 = \sqrt{16} = \sqrt[3]{64} = \sqrt[4]{256} = \sqrt[5]{1024} = \sqrt[n]{4^n}$.

As surds may be considered as powers with fractional exponents, they are reduced to others of the same value, that shall have the same radical sign, by reducing these fractional exponents to fractions having the same value and a common denominator. Thus $\sqrt[n]{a} = a^{\frac{1}{n}}$, and $\sqrt[m]{a} = a^{\frac{1}{m}}$, and $\frac{1}{n} = \frac{m}{nm}$, $= \frac{1}{m} = \frac{n}{nm}$, and therefore $\sqrt[n]{a}$ and $\sqrt[m]{a}$, reduced to the same radical sign, become $\sqrt[nm]{a^m}$ and $\sqrt[nm]{a^n}$. If you are to reduce $\sqrt[2]{3}$ and $\sqrt[3]{2}$ to the same denominator, consider $\sqrt[2]{3}$ as equal to $3^{\frac{1}{2}}$, and $\sqrt[3]{2}$ as equal to $2^{\frac{1}{3}}$, whose indices, reduced to a common denominator, you have $3^{\frac{1}{2}} = 3^{\frac{3}{6}}$, and $2^{\frac{1}{3}} = 2^{\frac{2}{6}}$, and consequently, $\sqrt[2]{3} = \sqrt[6]{3^3}, = \sqrt[6]{27}$, and $\sqrt[3]{2} = \sqrt[6]{2^2} = \sqrt[6]{4}$; so that the proposed surds $\sqrt[2]{3}$ and $\sqrt[3]{2}$, are reduced to other equal surds $\sqrt[6]{27}$ and $\sqrt[6]{4}$, having a common radical sign.

Surds of the same rational quantity are multiplied by adding their exponents, and divided by subtracting them; thus, $\sqrt[2]{a} \times \sqrt[3]{a} = a^{\frac{1}{2}} \times a^{\frac{1}{3}} = a^{\frac{3+2}{6}} = a^{\frac{5}{6}} = \sqrt[6]{a^5}$; and $\frac{\sqrt[3]{a}}{\sqrt[5]{a}} = \frac{a^{\frac{1}{3}}}{a^{\frac{1}{5}}} = a^{\frac{1}{3} - \frac{1}{5}} = a^{\frac{5-3}{15}} = a^{\frac{2}{15}} = \sqrt[15]{a^2}$; $\sqrt[m]{a} \times \sqrt[n]{a} = a^{\frac{m+n}{mn}}$; $\frac{\sqrt[m]{a}}{\sqrt[n]{a}} = a^{\frac{n-m}{mn}}$; $\sqrt[2]{2} \times \sqrt[3]{2} = \sqrt[6]{2^5} = \sqrt[6]{32}$; $\frac{\sqrt[2]{2}}{\sqrt[3]{2}} = \sqrt[6]{2}$.

If the surds are of different rational quantities, as $\sqrt[n]{a^2}$ and $\sqrt[n]{b^3}$, and have the same sign, multiply these rational quantities into one another, or divide them by one another, and set the common radical sign over their product, or quotient. Thus, $\sqrt[n]{a^2} \times \sqrt[n]{b^3} = \sqrt[n]{a^2 b^3}$; $\sqrt[2]{2} \times \sqrt[2]{5} = \sqrt[2]{10}$; $\frac{\sqrt[m]{a^4}}{\sqrt[m]{b^3 a}} = \sqrt[m]{\frac{a^4}{b^3 a}} = \sqrt[m]{\frac{a^3}{b^3}}$; $\frac{\sqrt[3]{9}}{\sqrt[3]{24}} = \sqrt[3]{\frac{9}{24}} = \sqrt[3]{\frac{3}{8}} = \frac{1}{2}\sqrt[3]{3}$.

If surds have not the same radical sign, reduce them to such as shall have the same radical sign, and proceed as before; $\sqrt[m]{a} \times \sqrt[n]{b} = \sqrt[nm]{a^n b^m}$; $\frac{\sqrt[m]{a}}{\sqrt[n]{x}} = \sqrt[mn]{\frac{a^n}{x^m}}$, $\sqrt[2]{2} \times \sqrt[3]{4} = 2^{\frac{1}{2}} \times 4^{\frac{1}{3}} = 2^{\frac{3}{6}} \times 4^{\frac{2}{6}} = \sqrt[6]{2^3 \times 4^2} = \sqrt[6]{8 \times 16} = \sqrt[6]{128}$; $\frac{\sqrt[3]{4}}{\sqrt[2]{2}} = \frac{4^{\frac{1}{3}}}{2^{\frac{1}{2}}} = \frac{4^{\frac{2}{6}}}{2^{\frac{3}{6}}} = \sqrt[6]{\frac{4^2}{2^3}} = \sqrt[6]{\frac{16}{8}} = \sqrt[6]{2}$.

If the surds have any rational coefficients, their product or quotient must be prefixed; thus, $2\sqrt[2]{3} \times 5\sqrt[2]{6} = 10\sqrt[2]{18}$. The powers of surds are found as the powers of their quantities, by multiplying their exponents by the index of the power required; thus the square of $\sqrt[3]{2}$ is $2^{\frac{1}{3} \times 2} = 2^{\frac{2}{3}} = \sqrt[3]{4}$; the cube of $\sqrt[2]{5} = 5^{\frac{1}{2} \times 3} = 5^{\frac{3}{2}} = \sqrt[2]{125}$. Or you need only, in involving surds, raise the quantity under the radical sign to the power required, continuing the same radical sign; unless the index of that power is equal to the name of the surd, or a multiple of it, and in that case the power of the surd becomes rational. Evolution is performed by dividing the fraction, which is the exponent of the surd, by the name of the root required. Thus, the square root of $\sqrt[3]{a^4}$ is $\sqrt[3]{a^2}$ or $\sqrt[6]{a^4}$.

The surd $\sqrt[m]{a^m x} = a\sqrt[m]{x}$; and, in like manner, if a power of any quantity of the same name with the surd divides the quantity under the radical sign without a remainder, as here a^m divides $a^m x$, and 25 the square of 5, divides 75 the quantity under the sign in $\sqrt[2]{75}$ without a remainder; then place the root of that power rationally before the sign, and the quotient under the sign, and thus the surd will be reduced to a more simple expression. Thus, $\sqrt[2]{75} = 5\sqrt{3}$; $\sqrt[2]{48} = \sqrt[2]{3 \times 16} = 4\sqrt[2]{3}$; $\sqrt[3]{81} = \sqrt[3]{27 \times 3} = 3\sqrt[3]{3}$.

When surds are reduced to their least expressions, if they have the same irrational part, they are added or subtracted, by adding or subtracting their rational coefficients, and prefixing the sum or difference to the common irrational part. Thus, $\sqrt[2]{75} + \sqrt[2]{48} = 5\sqrt{3} + 4\sqrt{3} = 9\sqrt{3}$; $\sqrt[3]{81} + \sqrt[3]{24} = 3\sqrt[3]{3} + 2\sqrt[3]{3} = 5\sqrt[3]{3}$; $\sqrt[2]{150} - \sqrt[2]{54} = 5\sqrt{6} - 3\sqrt{6} = 2\sqrt{6}$; $\sqrt{a^4 x} + \sqrt{b^4 x} = a\sqrt{x} + b\sqrt{x} = \overline{a+b} \times \sqrt{x}$.

Compound surds are such as consist of two or more joined together; the simple

surds are commensurable in power, and by being multiplied into themselves, give at length rational quantities; yet compound surds multiplied into themselves, commonly give still irrational products. But when any compound surd is proposed, there is another compound surd, which, multiplied into it, gives a rational product. Thus, if $\sqrt{a} + \sqrt{b}$ were proposed, multiplying it by $\sqrt{a} - \sqrt{b}$, the product will be $a - b$.

The investigation of that surd, which, multiplied into the proposed surd, gives a rational product, is made easy by three theorems, delivered by Mr. Maclaurin, in his Algebra.

This operation is of use in reducing surd expressions to more simple forms. Thus, suppose a binomial surd divided by another, as $\sqrt[2]{20} + \sqrt[2]{12}$, by $\sqrt[2]{5} - \sqrt[2]{3}$, the quotient might be expressed by $\frac{\sqrt{20} + \sqrt{12}}{\sqrt{5} - \sqrt{3}}$. But this might be expressed in a more simple form, by multiplying both numerator and denominator, by that surd, which, multiplied into the denominator, gives a rational product: thus, $\frac{\sqrt{20}+\sqrt{12}}{\sqrt{5}-\sqrt{3}} = \frac{\sqrt{20}+\sqrt{12}}{\sqrt{5}-\sqrt{3}} \times \frac{\sqrt{5}+\sqrt{3}}{\sqrt{5}+\sqrt{3}} = \frac{\sqrt{100}+2\sqrt{60}+6}{5-3} = \frac{16+2\sqrt{60}}{2} = 8 + 2\sqrt{15}$.

When the square root of a surd is required, it may be found, nearly, by extracting the root of a rational quantity that approximates to its value. Thus, to find the square root of $3 + 2\sqrt{2}$, first calculate $\sqrt{2} = 1,41421$. Hence $3 + 2\sqrt{2} = 5,82842$, the root of which is found to be nearly 2,41421.

In like manner we may proceed with any other proposed root. And if the index of the root, proposed to be extracted, be great, a table of logarithms may be used. Thus, $\sqrt[7]{5 + \sqrt[13]{17}}$ may be most conveniently found by logarithms.

Take the logarithms of 17, divide it by 13; find the number corresponding to the quotient; add this number to 5: find the logarithm of the sum, and divide it by 7, and the number corresponding to this quotient will be nearly equal to $\sqrt[7]{5+\sqrt[13]{17}}$.

But it is sometimes requisite to express the roots of surds exactly by other surds. Thus, in the first example, the square root of $3 + 2\sqrt{2}$ is $1 + \sqrt{2}$: for $\overline{1+\sqrt{2}} \times \overline{1+\sqrt{2}} = 1 + 2\sqrt{2} + 2 = 3 + 2\sqrt{2}$. For the method of performing this, the curious may consult Mr. Maclaurin's Algebra.

SURETY *of the peace.* A justice of the peace may, according to his discretion, bind all those to keep the peace who, in his presence, shall make any affray, or shall threaten to kill or beat any person, or shall contend together in hot words; and all those who shall go about with unlawful weapons, or attendance to the terror of the people; and all such persons as shall be known by him to be common barrators; and all who shall be brought before him by a constable, for a breach of the peace in the presence of such constable; and all such persons who having been before bound to keep the peace, shall be convicted of having forfeited their recognizance. When surety of the peace is granted by the Court of King's Bench, if a supersedeas come from the Court of Chancery to the justices of that court, their power is at an end, and the party as to them discharged.

If surety of the peace be desired against a peer, the safest way is to apply to the Court of Chancery or King's Bench. If the person against whom security of the peace be demanded be present, the justice of the peace may commit him immediately, unless he offer sureties; and *à fortiori* he may be commanded to find sureties, and be committed for not doing it.

SURGERY is that division of the healing art, which is chiefly conversant with the treatment of the external and local disorders of the body, of the effects of accidental injury, and of such diseases in general as are curable by manual operation. Yet its field is not entirely confined to the department just alluded to; since local disorders, and particularly accidents, often affect the whole frame, so as to induce a general derangement of the constitution; and again, diseases of parts arise out of constitutional affections, or, although originally independent, may be greatly aggravated by them. Hence it is obviously necessary that the surgeon should be acquainted with the nature and treatment of such general disorders; and consequently, in marking out the limits, which divide the departments of the surgeon and physician, it is hardly possible to attain such a pitch of accuracy as to prevent all supposed encroachment of either side on the province of the other.

The care of the external and local affections of the human body was, in the infancy of science, a branch of the art of medicine.

Surgery and physic were then, and for many ages afterwards, practised by the same individuals. These, however, in course of time, began to consider the manual and operative part of the profession as too mechanical and low for persons of their scientific education, and consequently resigned them to an inferior class of uneducated men, who generally combined with them the trade of the barber. Hence arose in most countries of Europe the calling of barber surgeon; which included, besides shaving, hair dressing, &c. tooth drawing, bleeding, dressing of ulcers, and other of the more common and easy parts of operative surgery. While contaminated by so degrading an alliance, and practised by persons wholly illiterate, we cannot be surprised to find that surgery and its professors met with neglect and contempt, and that the latter were considered as merely subordinate to the physicians. The barber-surgeons must still have had opportunities of seeing and learning disease; they began to get an insight into the structure of the human body; and they acquired a respectability by being employed in wars in the cure of the wounded. The physicians, who were still the only regularly educated and scientific class of men practising the art of healing, wished to retain their old and long enjoyed superiority; and hence arose in many countries long and sharp disputes with the barber surgeons, which ended at last, as the progress of civilization and improvement would naturally lead us to expect, in the separation of the barbers and surgeons, and the elevation of the latter to their proper rank and consideration in society.

Whatever part of the subject we may contemplate, we shall find that the art of surgery requires, no less than that of physic, all the advantages that can be derived from the most liberal education; that it demands still more imperiously a familiar knowledge of anatomy and physiology, i. e. of the structure and functions of that machine, whose derangements it proposes to remedy; and consequently, that although prejudice still assigns to the physician a superior rank to that of the surgeon, they must be considered in modern days, as equals, whether we regard the reason of the thing, or proceed to an actual comparison of individuals.

Our opinions concerning the education and qualifications of the surgeon will be easily collected from the foregoing observations. Instead of spending seven years of the most valuable part of his life in the drudgery of an apothecary's shop, the youth destined for the profession of surgery should receive a learned and liberal education. The Latin language among the dead, and the French of the living, are indispensibly necessary; and the German would form a very useful addition to these.

Anatomy and physiology are the next objects of attention, and demand the most assiduous cultivation: these sciences are the foundation on which the art of surgery rests. The study of chemistry and natural philosophy will be pursued at the same time. When prepared by these previous steps, the student may commence the practical part of his education in the large hospitals of the metropolis; carefully studying diseases themselves, taking notes of the most interesting cases, and omitting no opportunity of observing the alterations occasioned by disease in the structure of the body. Lectures on surgery, on the materia medica, and the practice of medicine must also be attended. The performance of surgical operations on the dead body will be highly beneficial, as leading to the study of those parts of anatomy, which are more particularly concerned in operations, and as imparting the manual skill necessary to the operator.

Of systematic works on surgery there is none, which unites the recommendations of clearness, shortness, and comprehension, to so great a degree, as the "First Lines of the Practice of Surgery," by Mr. S. Cooper, to which we therefore refer the reader. The larger systems are by no means unexceptionable; we may mention that of Latta; the "Systema Chirurgiæ hodiernæ" of Callisen; and the "Anfangs-gründe der Wundarzney kunst" of Richter. Generally, however, the works that treat of particular subjects are to be preferred to the systems of surgery. The writings of Mr. Pott, and the "Memoirs of the French Royal Academy of Surgery," contain a great deal of valuable information; as also do those of John Hunter, Home, Abernethy, and Astley Cooper; Le Dran, Sharp, Bertrandi, and Sabatier, may be read on the operations. The numerous other sources of surgical knowledge will be discovered by the student in his progress. The following sketch will be divided into general surgical subjects, or such disorders as are common to several situations in the body, including also the constitutional derangements which accompany or cause local disorders; and

particular surgical subjects, or the disorders and injuries of each particular part, and the operations practised on it. As the limits between surgery and medicine are rather artificial than real, these two branches of medical science touch each other in various points, and the physician and surgeon both claim a right to undertake the management of the same disorder. Hence the article MEDICINE of this work contains remarks on several diseases which are often treated by the surgeon; and we refer the reader to that article on the following points, viz. fever, tetanus, rachitis, scrofula, amaurosis, albugo, deafness, enuresis, ischuria, herpes, tinea, and psora.

GENERAL SURGICAL SUBJECTS.

Sympathetic Fever. No part of the animal body can be very considerably disordered, without occasioning a correspondent derangement of the whole constitution. Such disorder has been considered by Mr. Hunter as the result of universal sympathy. This consent of the whole constitution with its parts, manifests itself, in particular instances, by a greater disturbance of the functions of some organs than of others, and from this circumstance these diseases have derived the appellations, by which they are commonly distinguished. If the actions of the sanguiferous system be principally disturbed, and the temperature of the body subject to unnatural variations, the disease is termed fever; if the nervous system be chiefly affected, a state of vigilance or delirium may be produced; convulsions and tetanus take place when the muscular system is more particularly disordered. Though the especial disorder of particular organs thus gives a character and denomination to the disease, it is sufficiently evident, in every instance, that the whole constitution is disturbed.

The fever, which accompanies local accident or disease has been termed symptomatic, as if it were one of the symptoms of the local disorder; the epithet sympathetic is preferable, as it is founded on the real nature of the disorder, *viz.* a sympathy of the whole constitution for the disturbed state of a part.

The sympathetic inflammatory fever is accompanied with a frequent strong and full pulse, hot and dry skin, scanty and high coloured urine, dry furred tongue, thirst, loss of appetite and sleep; in some cases delirium.

When the local affection is in such parts as are essential to life, the powers of the constitution seem to be much depressed; and the pulse is frequent and small.

Treatment. The cure of the local inflammation, which excites and keeps up this sympathetic disturbance of the whole constitution, is the most effectual step for stopping the general disorder. But as the fever may react on the local disorder, palliative means may be necessary for the constitutional symptoms. Bleeding, saline purgatives, and diaphoretics, as the preparations of antimony, and the aqua ammoniæ acetatæ, are the best means. The use of the lancet is only advisable where the local mischief is to be feared on account of its situation or extent.

The sympathetic fever, just described, is produced by the irritation of a local injury upon a healthy constitution; when however the disease has continued unsubdued for a long time, the constitution still sympathises, although in a different manner; and the disorder then produced is called the sympathetic hectic fever. This form of constitutional sympathy attends such local affections as debilitate and harass the frame; and it is the reactive effort of an irritated and weakened constitution. The symptoms are a frequent small pulse, moist skin, pale and copious urine, great weakness, moist tongue, deficient appetite, often sickness, nocturnal sweats, loss of sleep, indigestion, &c.

Treatment. The alleviation or removal of the local complaint is the most effectual remedy. When this cannot be accomplished we must try to strengthen the patient; and if there were a medicine possessing the direct power of communicating strength to the constitution, these cases would be very proper for its employment. Particular symptoms may be combated, so as to keep all the functions in a state approaching as nearly as we can to that of health, and digestion promoted. Bark, with gentle cordial and aromatic draughts, are the most proper medicines. The food should be light and nourishing, and taken frequently in small quantities. Opium is often of great service, both in procuring sleep, and in checking the purging.

Disorder of the digestive Organs. The stomach and bowels bear a considerable share in the sympathetic derangements already considered. But in many instances of local complaints they are deranged in a still more striking way; and again, a dis-

turbed state of these organs arising from various causes will either give origin to various obstinate local complaints, or very much increase the difficulty of their cure. Many observations connected with this subject are scattered in the works of surgical writers; but the public are indebted for a general, scientific, and original view of the whole subject to Mr. Abernethy; to whose surgical observations we must refer the reader.

The symptoms of disordered digestive organs, whether induced by the irritation of local disease, or by other causes, as sedentary life, impure air, anxiety, and too great exertion of mind or body, are, diminution of the appetite and digestion, flatulence, and unnatural colour and fetor of the excretions, which are generally deficient in quantity. The tongue is dry, whitish, and furred, particularly at the back part, and this symptom is most apparent in the morning. As the disease advances, a tenderness is felt on pressing the epigastric region, and the urine is frequently turbid. Mr. Abernethy considers this affection to be a general disorder of all the organs concerned in the assimilation of our food; and that it consists in a weakness and irritability of the affected parts, accompanied by a deficiency or depravity of the fluids secreted by them; upon the healthy qualities of which the right performance of their functions seems to depend. The duration of the affection without fatal consequences, or indeed without any changes of structure in the parts, shows that it is only a disorder of functions.

When it is considered that this derangement of the chylopoietic viscera may bring on various diseases, and that local affections, occurring during its existence will become peculiar in their nature and progress, and difficult of cure, the importance of the subject will be readily allowed. A particular attention to diet is a point of primary importance in the treatment; and connected with this, the practice of taking five grains of powdered rhubarb an hour before dinner is very beneficial. A correction of any obvious irregularity in the intestines, and a regular diurnal evacuation of them are the next points to which we must attend. Purging is by no means advisable in the weakened state of these organs. The administration of small doses of mercury every night or every other night has a powerful effect in correcting disorders of the biliary secretion, and consequently in bringing the stools to their natural colour. Vegetable diet-drinks, as the decoct. sarsaparill. comp. have been advantageously combined with these means. The cause of the disorder may be more completely relieved by good air, exercise, and mental tranquillity, while the medical assistance above-mentioned counteracts the effects. By such simple treatment as we have just mentioned, obstinate and extensive local diseases of the most opposite classes, which have resisted all the ordinary methods, will often be either entirely cured, or very signally relieved.

Tetanus, or locked jaw, is one of the most alarming consequences of local injury. It is most frequent in warm climates, in the male sex, and in the robust and vigorons. It does not appear till many days after the accident, and frequently when the wound is quite healed. Injuries of the fingers and toes are its most frequent causes.

Symptoms. The muscles of the lower jaw first become stiff, and then rigidly contracted, so that the mouth cannot be opened. Those of the neck, back, and whole body, are successively affected in the same manner. The spasm, however, is not constant, as violent and most painful convulsions occasionally agitate the whole frame. The progress is various; when rapid, the patient scarcely ever recovers; but if he survive the fourth day, the prognostic is much more favourable. The vital functions are but little affected.

Treatment. When the symptoms have come on, there seems to be no connection between them and the original local cause; so that no assistance can be derived from this source. Opium in very large doses, as a grain in two hours, and then gradually increased; and the same remedy by the way of clyster, and in frictions seems to have afforded the most relief. The warm bath, camphor, volatile alkali, and musk, according to circumstances. Large quantities of wine have been recommended; and in some cases the cold bath during the spasm has relieved. Salivation is useless.

Inflammation, in some of its states or varieties, is presented to our view in almost every surgical disease, and consequently particularly demands the attention of the surgeon. It occurs as a natural means of cure in many species of accidental injury; and here it is considered as healthy: it may also be regarded in the same light where it follows any local irritation in a healthy constitution and part. In other cases it is com-

plicated with some morbid tendency, as in erysipelas, scrophula, lues venerea, &c. and hence arise numerous species of unhealthy inflammation. Again, it may be acute or chronic, in respect to its duration.

Healthy acute inflammation has been called phlegmon. Its symptoms are preternatural redness, increased heat, and a circumscribed, throbbing, painful swelling of the inflamed part. The exciting cause is generally some external violence, of a mechanical or chemical nature. Sometimes it arises spontaneously; or, in other words, no perceptible cause can be assigned for it. The proximate cause is an increased action of the vessels of the part.

During its existence in any important organ of the body, blood taken away from the system has the inflammatory crust, or buff, on the upper surface of the clot, which is at the same time concave, or cupped.

Treatment. 1. Removal of the cause, where that is practicable. 2. Bleeding, both topical and general. The latter is only necessary when the inflammation of the organ endangers life itself, as the brain, lungs, liver, &c.; or when the part has inferior powers of recovery, as a joint; or where suppuration would entirely destroy the organ, as in ophthalmy. The former is effected by means of leeches, or cupping. 3. Purgatives, chiefly of the saline kind, as Glauber's and Epsom salts, &c. 4. Antimonial medicines, which relieve the skin, and diminish febrile action. 5. Reduced diet, including abstinence from fermented or spirituous liquors, and animal food. 6. Evaporation constantly kept up from the surface by folded cloths, wetted with cold washes. This is very powerful in reducing the heat and increased actions of the part. A solution of ceruss. acetat. ℥ss. in ℥iv. of vinegar and ℔ij. of distilled water is a very good application. Where, on account of concomitant extravasation of blood, as in bruises, it is desirable to excite the absorbents, washes supposed to have this effect, and therefore termed discutients, are employed: such as ℞. ammon. muriat. ℥ss. aceti et spir. vin. rectif. āā ℔ j. 7. Warm applications, as poultices or fomentations, occasionally relieve, when the cold washes are ineffectual.

Inflammation terminates in resolution, which is the gradual subsidence of all the symptoms; in suppuration, or the formation of matter; or in mortification.

Suppuration. The inflammatory symptoms, instead of yielding to the treatment, are aggravated; and afterwards suddenly subside, the patient being seized with shiverings. The swelling becomes softer, and white at its most elevated part; and if the collection be superficial, a fluctuation can be felt. At this time a fluid, called matter, or pus, is contained in a cavity formed in the centre of the inflamed part, and termed an abscess. This peculiar fluid is separated from the blood by the inexplicable power of the secerning arteries, just as ordinary secretion takes place. In a healthy state it is a homogeneous light yellow fluid, about the consistence of cream, and possessing little smell; but under many circumstances of disease its appearance and properties are entirely changed. The cyst, containing the pus, has a smooth and somewhat villous surface: it seems to be lined with a layer of coagulating lymph, and the surrounding cellular substance is thickened and agglutinated by the inflammation, so as to prevent the matter from spreading. From the arteries of this part the pus is secreted.

The matter always makes its way towards the external surface of the body; even if the parts should be very much thinner, and less resisting towards any cavity.

Treatment. A soft poultice until the abscess bursts, or has been opened. The latter operation is performed by a straight two-edged scalpel, or an abscess lancet. It is not necessary, unless the collection be under a fascia, which may prevent it from coming forwards; or near a joint, or large cavity of the body, as the belly or chest. A poultice should still be applied after the bursting of the abscess.

Mortification ensues when the violence of the inflammation, or its duration, has completely exhausted the powers of the part. The pain subsides; the part becomes livid, or otherwise discoloured; the cuticle is elevated into a vesication by a turbid fluid; the pain and tension are diminished; and air is disengaged into the cellular substance, so as to cause a crackling sensation. To this stage the term gangrene is applied; but when the part has become quite black, and has lost its motion, sensation, and heat, it is called sphacelus.

The blood coagulates in the large vessels leading to the part, and consequently the separation of the limb is not followed by hemorrhage.

But mortification often occurs without preceding inflammation in parts and subjects where there is great weakness. Tying

the artery of a limb; impeding the return of the venous blood; continued topical pressure in a weak constitution; cold, when followed by the opposite extreme; are causes of this description. A peculiar mortification, beginning at the toes of old persons, and proceeding upwards, is of this kind.

When the mortification has stopped, a defined boundary separates the dead and living parts; the lymphatics remove the connecting matter, so as to form a groove, in which suppuration commences; and this groove extends deeper and deeper until complete separation is effected. Our treatment must be directed to the object of stopping the disorder; in which view attention to the constitutional disturbance, that is usually very great, is of primary importance. The state of the digestive organs will demand particular attention. The great pain frequently requires opium. Cold washes while the inflammation continues high; and afterwards a poultice of bread or linseed, alone, or in combination with very finely powdered charcoal, are the best topical means. Amputation of a limb can never be allowed, until the line of separation between the dead and living parts is clearly formed. When the inflammation has abated, and the separation is going on, (which should in general be left entirely to nature) the constitution should be strengthened by every means both of food and diet. Hence bark, with wine and aromatic confection; fermented liquors, and a nourishing diet, become proper. Bark, however, is by no means so universally beneficial in mortification as many surgeons suppose: if sympathetic inflammatory fever be present, or derangement of the chylopoietic organs, it would certainly be hurtful; but, where debility shows itself, this remedy must be instantly employed. Opium is often very serviceable; and it has been represented by Mr. Pott as almost a specific in the mortification of the toes and feet of old persons, where it must be used in a very free way. The same remedy will be of service in other cases, where the disorder is preceded and accompanied with great pain, but not inflammation.

Erysipelas is a species of superficial inflammation, in which the red colour is tinged more or less with yellow, particularly towards the termination; it spreads rapidly and widely; there is swelling, without much elevation, hardness, or circumscription. The skin is glossy, and its colour disappears on pressure. The pain is of a burning or itching kind. It often changes its seat; and is attended, when it recovers, with desquamation of the cuticle. Sometimes vesicles are formed. It seldom suppurates; but when it does, the abscesses are very extensive, as adhesions seldom take place, to limit the expansion of the matter. Mortification ensues in some instances.

The constitutional affection varies considerably, according to the degree of local disturbance. Languor, head-ache, loss of appetite, nausea, vomiting, oppression of the stomach, and foul taste in the mouth, precede. It is most dangerous in the face, and attended with the greatest disturbance, often amounting to delirium.

Disorder of the chylopoietic viscera, and suppressed perspiration, are the most prominent causes of the complaint. Mild purgatives, diaphoretics, and the antiphlogistic regimen, are sufficient in the slighter cases. In more severe attacks, calomel, combined with other purges, and antimonials, is proper. Emetics, where the stomach is much distressed. Bark may be required after the disorder subsides. Cold washes, or poultices, to the part, as they seem to agree: the former are preferable, on the principle of checking the inflammation.

Carbuncle is a very violent unhealthy kind of inflammation, attended with a painful deep discolouration of the skin, a very remarkable thickening and induration of that part, and gangrenous suppuration under it, occurring usually at the back part of the trunk, and often constituting a symptom of the plague and other malignant fevers. Its size varies considerably. Openings form in the swelling, and give issue to a very offensive discharge; and in the end extensive mortification ensues. The fever, which is at first inflammatory, soon becomes typhoid; and strong marks of chylopoietic derangement are generally attendant.

The swelling must be completely laid open by a free incision through the brawny skin, so as to discharge all the matter and sloughs. Purgatives and emetics are proper for the disturbed digestive organs; and the debility which remains after the disorder has subsided, demands strengthening medicines and food. Opium when the pain is excessive.

Boils are similar to carbuncles, except that they are smaller, and require the same treatment; the state of the chylopoietic organs must be particularly regarded.

Œdema is an unusual accumulation of

water in the cellular substance, occasioning a general swelling of the part, without discolouration, that pits on pressure, is uneasy rather than painful, and increases in a depending position. It arises from constitutional, or local weakness. In the latter case, which alone belongs to surgery, let the cause be removed; put the limb in a horizontal posture; employ frictions with flannel, and camphorated, or other slightly stimulating applications, and then apply a moderately tight roller.

Burns are attended with violent inflammation of the part, severe pain, and fever. The cuticle is raised into clear yellow blisters. The part may be destroyed at once, and converted into a dead black substance, or it may slough from the subsequent inflammation. If vesications do not form, suppuration will probably not take place. Where the injury is very extensive, the breathing is much affected.

As burns are violent local inflammations, the antiphlogistic treatment, both locally and generally, was the usual surgical practice, until Dr. Kentish, who then practised surgery at Newcastle, introduced the opposite, but as subsequent experience has proved, much more successful plan of applying hot oil of turpentine, or alcohol, and then covering the part with a liniment composed of ung. resin. flav. and ol. tereb. on the principle of maintaining the action of the part by an adequate stimulus, which is to be gradually diminished. The first dressing remains for twenty-four hours; and in the second, warm proof-spirit, or laudanum, may be used before the plaister is applied; which alone suffices for the third. When suppuration commences, powdered chalk, and a plaister of cerat. lap. calam. Opium and good diet are to be allowed at the commencement of the treatment, with the topical stimulus.

Effects of cold. When a limb has been frozen, heat must be communicated to it very gradually. The sudden application of considerable warmth will inevitably cause mortification. Rub the part with snow, as persons in northern countries do their ears or noses when thus affected, or with cold water, until motion and sensibility return. Then camphorated spirit of wine may be used, and ultimately, a moderate approach to the fire may be allowed; or else the patient may be put in a warm bed, and warm flannels may be applied locally; general perspiration being at the same time promoted. The same principles must be kept in view when the whole body is affected. Volatiles and sternutatories may be used when animation has returned; and warm wine, or spirits, should be introduced into the stomach as speedily as possible.

Chilblains are caused by exposure of parts to the vicissitudes of heat and cold, particularly in young persons, females, and such as are brought up tenderly. Before they are ulcerated ice, cold water, or snow, may be applied two or three times a day; and the parts should be kept dry, and in an uniform temperature. In some cases, topical stimulants seem more beneficial, as spir. vin. camph. or tinct. myrrhæ rubbed in; also vinegar and alum lotion. Sp. vin. camph. and tinct. cantharid. in equal parts, have been very useful.

WOUNDS.

These vary so much according to their extent, the degree of violence employed, the powers of the part, its importance to life, complication with bleeding, fracture of bones, &c. that they must be considered under various heads.

The size of the wound is a matter of consequence; as a very large cut may produce serious consequences, although no important parts are injured. The degree of violence done to the fibres is another material consideration: a wound in which the parts have been bruised, stretched, and lacerated, as well as divided, will often mortify from that cause only; hence contused and gunshot wounds are particularly dangerous. Such injuries too as expose circumscribed cavities are alarming, on account of the inflammation which generally follows such exposure; hence the danger of even a slight wound in the belly, chest, or large joints. A slight wound of a part whose functions are intimately connected with life, is often fatal.

Simple incised wounds require only that the sides should be brought into a state of apposition, and maintained in that condition; by means of adhesive plaister, assisted perhaps by bandage.

Hemorrhage, which frequently attends these injuries, demands particular care, as it must be stopped before any thing else is done. If the blood flow from an artery, it is a florid red, and comes out in jets; if from a vein, the stream is uniform, and the colour dark purple. If the vessel be not large, the bleeding often stops of itself. The divided artery retracts; the surrounding cellular substance, becoming injected with blood, presses on its mouth; and,

finally, the blood coagulates in the orifice. Thus the sides of the vessel grow together. But death would often take place before the bleeding stopped in this way, particularly if the vessel were large; or, at all events, great danger would arise from the bleeding. Hence it is always desirable to tie the mouth of the bleeding vessel, which secures us at once from all alarm on the subject of hemorrhage. A ligature, when properly applied, is found to cut through the two internal coats of an artery; the inflammation thus excited in the vessels of the part is attended with an effusion of coagulating lymph, which, together with the coagulation of the blood, effectually closes the tube, before the separation of the thread, which is seldom delayed beyond a fortnight. The ligature should include the artery only; or, when it is small, as little surrounding matter as possible; when the vessel is large, it may be drawn out with the forceps: in the latter case a tenaculum must be used. As much force may be employed, in drawing the knot, as can conveniently be exerted by the hands.

The use of the ligature, in hemorrhage, is preferable to every other means: the tourniquet may be placed on the limb, until the vessel is found and secured. When the main arterial trunk of a part is compressed by the pad of this instrument, there is no immediate danger of bleeding.

The tourniquet, in common use, for which we are indebted to a French surgeon, Petit, consists of a band and buckle, a pad, and a sort of brass bridge, capable of being elevated and depressed by means of a screw. The band is first buckled round the limb in such a manner that the pad, which is attached to the band, is placed exactly over the artery. The bridge, over which the band proceeds, is to be then raised by turning the screw, and thus a due degree of pressure is produced. It affords, however, only a temporary security. When a tourniquet cannot be procured, pressure may be made by any simple ligature round the limb, twisted to the requisite tightness by means of a stick.

Compresses and bandages will sometimes stop bleedings by their mechanical pressure; but are inferior to the ligature. If the bleeding vessel cannot be found, if there be rather a general oozing than an hemorrhage from any considerable vessel, or if the artery lie against a bone, as those of the scalp, this method may be employed.

When a large artery has received a small wound, as the brachial in bleeding, the following plan may be tried. Apply a tourniquet so as to command the flow of blood into the vessel. Bring the edges of the external wound into contact. Bind on firmly with a roller a graduated compress, with the apex placed exactly in the situation of the wound of the artery. A longitudinal compress has sometimes been added in the course of the vessel, above the wound; but it would probably impede the circulation too much. Then let the limb be kept perfectly quiet.

The use of agaric, of the actual and potential cautery, and of styptics, as means of arresting hemorrhage, are banished from modern surgery.

When bleeding is stopped, and all foreign bodies, or coagula of blood, have been removed, the sides of the wound should be approximated by means of sticking-plaster, assisted, if necessary, by the position of the part, by bandage, &c. In forty-eight hours the sides of a wound, healed in this way, will be agglutinated, and the process by which they are united, is named "union by the first intention." Sutures were formerly employed in the treatment of such wounds, but their use is restricted now to the very few cases where the sticking-plaster cannot be conveniently applied, as the harelip, &c. They have fallen into disrepute as a general mode of treating wounds, principally because they tend to increase inflammation. The new wounds which they make, their irritation as extraneous bodies, the forcible manner in which they drag the living parts together, and their incapacity, in general, to accomplish any useful purpose, which position, adhesive plaster and bandages cannot effect, are strong motives for reprobating their general employment. They often bring on such irritation as to render their removal necessary.

The sides of a wound, treated in the way now described, throw out coagulating lymph, which joins them together. This forms an uniting medium, through which new vessels shoot from the opposed surfaces. We cannot help admiring the celerity with which this uniting process is completed. The wound produced in amputating a thigh is often securely united in seventy-two hours; and the principles now detailed apply to the management of all wounds made by surgical operation.

Punctured wounds are often attended with more pain, inflammation, &c. than others. Enlarging their orifice is an unnecessary

practice, unless abscesses, or extracting foreign bodies should demand it. A soothing plan, by means of emollient poultices, &c. is preferable.

Lacerated and contused wounds, on account of the violence attending their infliction, do not unite like simple cuts by the first intention. Yet they should be brought together, and inflammation obviated by the appropriate treatment.

If a wound does not unite by the first intention, it must granulate and cicatrize. Pus is secreted from its surface, which becomes red and uneven, rising into little protuberances, called granulations. These fill up the cavity of the wound to a level with the skin, which then grows over and covers them by a newly formed smooth pellicle, termed a cicatrix. When this process is completed, the newly-formed part is absorbed to a great degree, and hence the surrounding healthy skin is drawn from all sides over the situation of the wound, presenting a puckered appearance.

Gunshot wounds are attended with great laceration and violence, insomuch that the parts in their track are killed, and must be thrown off in the form of sloughs. They are very often complicated with fractures, wounds of arteries, viscera, &c. and with the introduction of foreign bodies, as balls, portions of clothing, &c.

Immediate amputation is often necessary in gunshot wounds of the limbs; and often there is much doubt whether this means should be adopted or no. It may be done immediately after the accident, before suppuration, fever, &c. have supervened; or when the violent inflammation, swelling, &c. have abated. By deferring it to the latter period, the surgeon has often a chance of saving the limb; and if he does not succeed, he operates under more favourable circumstances, as a patient habituated to disease bears an operation much better than a person in good health. Yet this is not meant as an argument against immediate amputation in any case; for by that practice a simple incised wound is substituted for a complicated lacerated one; and the constitution escapes that hazard which repeated suppurations, painful incisions, &c. are inevitably attended with. Besides, after the constitution is nearly ruined by the processes of recovery from a dreadful injury, the limb is often no better than a wooden one.

Incisions at the entrance and exit of the ball are not necessary, unless there is an object to be accomplished. Foreign bodies should be extracted if it can be done easily; but tedious examinations and incisions are improper, particularly when the belly or chest are wounded. The mildest dressings and treatment should be employed. Fomentations and poultices, and dressings of white cerate, answer every end.

Poisoned wounds. The stings of bees, &c. the bites of gnats, and other insects, are treated by cold applications, and attention to the constitution if the general irritation be great. In the bite of the viper, alarming symptoms usually arise; viz. swelling, heat and pain of the limb; small and weak pulse; head-ache and vomiting, &c. Perhaps excision might be proper at the very first; or, at all events, the wound should be carefully cleansed. Emetics, and volatile alkali, have been commended as constitutional means.

Hydrophobia arises from the bite of a mad-dog, or other rabid animal. The wound heals, but in about three weeks a dull pain is again felt in it. Dejection of spirits appears at the same time, followed soon by the dread of water; and intolerable sense of suffocation and convulsions at any attempt to swallow fluids. Horror of the countenance, redness of the eyes, convulsive and violent movements, &c. continue to the time of death. Excision of the bitten part is the only preventive; it should be employed at any time previous to the accession of symptoms; the use of caustic, &c. is very uncertain. No remedy is of the least use when the symptoms have appeared.

Contusions, when slight, may be treated by cold applications, and quietude of the injured part. In other cases, topical bleeding, followed by discutient lotions, as sal ammoniac in vinegar and water, or fomentations of hot vinegar, and afterwards camphorated liniment, are required. Purging and venesection are sometimes necessary.

Polypi are fleshy excrescences, growing from a thin pedicle, and occurring most commonly in the nose and uterus. Those of the nose are divided into the fleshy, or benign, which are white, soft, and unattended with pain; and the malignant, which are hard and painful, and according to some, of a carcinomatous nature. They grow most frequently from the spongy bones; occasion at first an obstruction of the nose, and gradually fill up the whole cavity; extend backwards to the throat; expand the nostril by elevating the os nasi; destroy the other

bones; and produce, succesively, fistula lachrymalis, inflammation and ulceration of the schneiderian membrane, caries of the bones, &c.; some often bleed. They must be extracted by means of forceps; by which the tumour is seized, and torn away from its root. This process must be repeated until the nostril is cleared. If any present in the throat, they may be removed in the same way from that part. If troublesome bleeding should follow, and not yield to a probe armed with lint, moistened in a strong solution of white vitriol, and applied to the part; a piece of lint may be drawn into the posterior opening of the nose, by means of a ligature introduced through the nostril, and drawn out at the mouth; the front aperture being also stopped.

Polypi of the uterus occasion at first an enlargement of that organ, and various other symptoms, as pain, hemorrhages, &c. The tumour escapes from the uterus, and by its presence in the vagina irritates the rectum and bladder; causing still worse uterine affections, as bleedings, discharges of other kinds, &c. At last it descends through the external parts, with an aggravation of all the distressing symptoms. Now it must be carefully distinguished from the prolapsus, or inversic uteri. It should be removed by means of a ligature conveyed to its root in the uterus, by instruments designed for that purpose, as the double canula of Levret, or the improved instrument of Richter, represented in Cooper's "First Lines."

Ulcers are consequences of wounds that have not united by the first intention; or of a diseased process, named ulceration, in which a breach is made in the substance of the body by the absorbents. A healthy ulcer has small florid and pointed granulations, which secrete a thick white pus. Here any simple dressing, confined by means of a roller, is sufficient.

But the ulcer may be irritable, *i. e.* attended with pain, a thin and discoloured secretion from its surface, ragged edge, no distinct granulations, &c. Here decoction of poppy heads, used as a fomentation, emollient poultices, solution of opium (ʒiss to ℔j of water) are proper; or it may be indolent, *i. e.* not painful, having thick edges, flabby colour, and imperfect granulations. Irritable ulcers are brought into this state by too long poulticing. Stimulating applications to the sore are proper here; as red precipitate, solution of lunar caustic, &c. combined with a roller applied uniformly and firmly over the whole limb. But the most successful treatment is that proposed by Mr. Baynton, of Bristol, of surrounding the limb, for a considerable extent, with straps of adhesive plaister, applying a roller, and keeping wet cloths on the part, if there be pain. This practice indeed often succeeds, where the ulcer is of the irritable cast: the pressure of the roller is useful, and the cold water relieves the pain. It is most particularly beneficial in ulcers of the legs, attended with varicous veins; and, in short, is a very great improvement in the surgical treatment of ulcerated legs, as it does not require the patient to be confined.

There are various ulcers, not included under this arrangement, having peculiarities in their appearance, discharges, &c. They are often connected with disordered chylopoietic organs.

Encysted tumours consist of a cyst of various thickness, containing a matter of very different consistence and appearances; according to which the tumour is called meliceris, the contents resembling honey; atheroma, when of a pappy nature; or steatoma, when of a fatty kind. They must be extirpated, care being taken to remove the whole cyst in an intire state.

Sarcomatous tumours are fleshy masses, organized throughout, produced by chronic inflammation, sometimes being newly formed; at others merely enlargements of originally existing parts, possessing a more or less defined cyst or capsule, which is formed by a condensation of the surrounding cellular substance. Their structure is very various, sometimes consisting entirely of fat, at others of a fleshy vascular mass, in which there may be cysts, or division into something like lobes, &c. In the rapidity of their growth, pain, &c. they differ very much; some also affect the lymphatics, which others do not. As they are produced by chronic inflammation, local bleeding and cold washes will generally arrest their growth, and often reduce their size. Topical stimuli may also be employed with the view of discussing them; but extirpation is the only plan to be relied on. The mode of operating will be explained in speaking of the amputation of the breast.

Carcinoma commences with a hard painful tumour, termed a schirrus, which ulcerating forms cancer. As several other swellings are both hard and painful, discrimination becomes particularly necessary. Schirrus has an uneven feel, is attended

with occasional darting pains, affects all the surrounding parts, so that the tumour becomes fixed to the muscles and skin, which latter has a dull leaden colour. When cut into it exhibits a hard gristly appearance, with white ligamentous bands, extending into the surrounding fat. When it becomes a cancer, a large chasm is formed by ulceration and sloughing: the sore is unequal, with thick indurated edges, and copious discharge of fetid sanies, combined frequently with bleeding. A fungus often arises. Previously to this period the absorbent glands are generally swelled, and they afterwards take on the same disease. Extirpation in the earliest state is the only safe treatment: it may be performed after the glands are affected; but then those also should be removed. Here, however, as well as when ulceration has occurred, the disease often recurs. Cicuta, belladonna, digitalis, mercury, arsenic, &c. have been tried internally without success. Opium is necessary as a palliative. Caustics composed of arsenic have often been used, in order to destroy the tumour by sloughing, probably never with success in a true schirrus.

Ganglions are small hard tumours, not painful, containing in a cyst a fluid like white of egg; connected with a tendon, and occurring most frequently on the hands. Pressure, stimulating applications by means of friction, or extirpation by the knife, may be employed.

Aneurisms are swellings formed by the dilatation or rupture of arteries; the former being named true, and the latter spurious; but this distinction is of little use in practice. The tumour pulsates, except when the artery above is compressed; it is not painful; it may be made to disappear by means of pressure in an early stage. When it has grown to a great size, the pulsation is often diminished, for at first the blood does not coagulate in the bag, which is the case afterwards to a great extent. The size of the tumour becomes very inconvenient, its pressure causing œdema, caries, &c. The skin at last grows thin and bursts, when the patient dies of bleeding. Aneurisms of this kind generally occur spontaneously, from a diseased state of the arterial coats; but sometimes a strain or blow gives rise to them.

When an artery is wounded, and the blood escapes into the cellular substance, a false aneurism is formed. This happens at the bend of the arm from bleeding. The swelling is irregular, the skin livid; and pulsation may or may not be present.

The *varicous aneurism* is where the artery has been wounded in phlebotomy, and the blood escapes from it into the vein, causing a varicous enlargement of that vessel, with pulsation, and a peculiar hissing noise. This is not dangerous, and requires no treatment.

The *treatment* of aneurism consists in preventing the flow of blood into the tumour, which then gradually diminishes. Hence it is obvious that those of the aorta can admit of no remedy. In the limbs, however, they may be cured by the operation of exposing the artery at a considerable distance from the tumour, nearer to the heart, passing a double ligature under it, tying these at the parts where the vessel is surrounded by its natural connections, and dividing it between them. A single ligature will be sufficient, but it is not so safe. In this way any artery may be operated on, from the axillary above the clavicle, the external iliac above the crural arch, and the carotid by the side of the trachea, down to their respective ramifications. The false aneurism should be opened opposite to the wounded part of the vessel, the tourniquet being previously applied; the coagula removed, and two ligatures placed on the artery as in the preceding kind.

Varices are dilatations of the veins, occurring in parts where the return of the blood is contrary to gravity, or where pressure is made on the trunks so as to obstruct that return: hence they are most frequent in the legs. The affected vessels swell into irregular knots, in which the blood is at first fluid, but afterwards coagulated. The complaint at first is not painful, but afterwards becomes so, and gives rise to troublesome ulcerations. The vessel sometimes bursts, and considerable bleedings follow.

The cause should be removed, and a tight bandage applied, the horizontal position being preserved. When this treatment does not succeed, the trunk of the vein may be tied with two ligatures, and divided between.

Hemorrhoids, or *piles*, are varices, often attended with hemorrhage. Leeches, cold applications, attention to regimen, open state of bowels, and balsam copaivæ, are means of temporary palliation. A radical cure may be effected by cutting off the excrescences with scissars, or tying them.

Scrophula attacks particularly the lymphatic glands and bones, occasioning a soft

indolent swelling in the former, and a softening, together with a carious affection, of the latter. After remaining enlarged for a long time, the skin, covering a scrofulous tumour, becomes of a light purple, and bursts, discharging an unhealthy matter, and leaving an ill-conditioned sore. Such attacks take place in several parts. They generally occur in peculiar constitutions, and the affection is considered hereditary. In the treatment we endeavour to give strength to the constitution; bark, sea-air, and sea-bathing are particularly serviceable. Attention to the digestive organs is particularly necessary. Alkalies have generally been relied on, but without due grounds; acids deserve a preference. The local treatment is not of much importance. The suppurations should not be opened. The scrofulous affections of the bones will be considered under *Joints*.

Cow pox (variolæ vaccinæ, vaccina, &c.). This is an universal poison, derived from certain specific sores on the teats and udders of cows, and capable of being communicated by accidental contact, where the cuticle has been removed, or by means of inoculation, to the human subject. A person who has been thus affected, is rendered for ever after incapable of receiving the small-pox infection. That subjects, who had taken the vaccine disease accidentally, were thereby secured from the small-pox, was popularly known in several of the dairy counties of England. But it was reserved for Jenner to show that the cow-pox could be propagated by inoculation, and that the inoculated disease possessed the same prophylactic power as the original disorder. It is not a merely local affection, but produces a general, though extremely mild disturbance of the constitution, which is ordinarily so trivial as not to excite any alarm in the very youngest subjects. It seems probable, at present, that it is not an infallible security against the small-pox, although the number of failures is very small, when due allowance has been made for the mistakes of the ignorant, and the misrepresentations of the designing. A small inflamed spot, distinguishable about the third day, shows that the inoculation has succeeded. This increases in size, becomes hard, and rises above the level of the skin. A small quantity of fluid can be discerned in the centre on the sixth day, and the pustule increases until the tenth day. This fluid will communicate the disease by inoculation. On the eighth day, when the pustule is fully formed, the constitutional effects begin to appear, and manifest themselves by slight pain in the part and axilla, headach, shivering, loss of appetite, &c. These subside spontaneously in one or two days. During the general indisposition the pustule becomes surrounded with a broad circular inflamed margin, called the areola. Afterwards the fluid dries up, and a dark brown scab forms, which remains for about a fortnight.

Venereal disease. This arises from the application of a peculiar morbid poison to the body, which affects various parts in succession. It first attacks the genitals of either sex, where it appears in the form of a circular ulcer or ulcers, with a white dirty concave surface, and thickened edge and basis, called chancres. These characters distinguish them from various other ulcerations and excoriations, to which the same parts are exposed. The matter absorbed from these causes swellings of the lymphatic glands, named buboes. After a certain length of time, an ulcerated sore throat appears, attended with a peculiar copper-coloured eruption on the skin. The ulcer of the throat is excavated, and the chasm appears foul on the surface, with an appearance like a white slough, and a defined edge. The eruptions vary considerably; they have generally a reddish colour; the cuticle peels off and forms again successively; at last a true scab appears, under which ulceration takes place. After some time swellings of the bones, called nodes, appear, and gradually suppurate. These are very painful, particularly at night. The affections of the throat, skin, and bones, form what are called the constitutional symptoms of the disease, or lues venerea.

The treatment of this disorder, in all its stages, consists in the exhibition of mercury, until it produces its peculiar effects on the constitution: these are universal irritability, quick pulse, &c. together with increased secretion of saliva, soreness of the gums and mouth, &c. This action excited by mercury destroys the action of the disease in all its forms, and may be considered as a specific and certain cure of the disorder. The remedy is most frequently introduced by friction on the thighs; half a drachm being first employed for half an hour every night, and increased to two or three drachms. The pil. hydrarg. is the most common preparation for internal use; it may be taken at first in doses of five grains, morning and night. Hydrarg. calcin. gr. j.

with opium, and corrosive sublimate, are less frequent modes of exhibiting mercury. Lastly, mercurial fumigations have been employed, by exposing the patient naked, in a wooden box, to the fumes of the pulvis hydrarg. cinereus, thrown on a heated iron. The effect of mercury on the salivary secretion and gums, is considered as the criterion of its action on the system at large; this should not be allowed to become considerable, as the effects on the constitution are very pernicious. A very slight affection of the gums, continued from six to twelve weeks, will be adequate to the cure of most venereal complaints. The action of the remedy is usually maintained for a fortnight after the symptoms have disappeared, for the sake of security. Violent and long continued salivation often aggravates the complaint, and becomes the source of other disorders. Decoction of sarsaparilla, mezereon, guaiacum, &c. nitrous acid, opium, and other remedies, have been employed in venereal cases, but the most that can be said of them is, that they are useful restoratives after the long employment of mercury. This is particularly the case with the nitrous acid.

There is not much to be said on the local treatment of the different venereal symptoms. Chancres, when very small, have been destroyed by lunar caustic, or excision; they may be dressed with mercurial ointment, or any solution of metallic salts, or with solution of opium if irritable. Buboes may be poulticed, if painful.

AFFECTIONS OF JOINTS.

White swelling attacks the larger articulations most frequently. It consists in an indolent tumour of the part, without affection of the skin, impairing the motions of the joint, arising from a diseased state of the bones and ligaments, which causes a general thickening of the superincumbent parts. The enlargement proceeds, the joint becomes painful, and abscesses form; the patient at last dying hectic. The treatment consists in subduing completely all increased action in the part by leeches, cupping, cold washes, &c. continued while there is any remains of pain or heat, and afterwards in keeping up a drain from the skin by means of caustic issues, or, what seems to be more advantageous, by Mr. Crowther's plan of blistering, and dressing the surface with unguentum sabinæ. These drains should be continued for six, twelve, or eighteen months. Perfect rest is indispensible. The constitution of the patient which is frequently of the scrofulous kind demands the greatest care: bark, sea-air, &c. are therefore particularly proper in such cases. Where the joint is too thoroughly diseased, and the constitution is sinking, amputation must be performed.

Loose cartilaginous substances are most frequent in the knee, where they excite inflammation, and are very troublesome, when they get between the ends of the bones. They must be removed by means of an incision over the inner surface of the internal condyle, where they can be easily fixed by an assistant; the wound should be closed instantly, and every attention paid to keep off inflammation.

Hydrops articuli occurs after inflammation or injury, and may be dispersed by blisters and savine ointment, or by friction with camphorated liniments or mercurial ointment, united with mercurial purges.

DISEASES OF BONES.

Necrosis is the death of the whole of a bony cylinder, excepting its articular portions, and is most frequent in the thigh and tibia. The periosteum separates from the affected bones, becomes thickened and vascular, and forms a new case surrounding the old bone, and at last absorbing it. This process occupies many years; is attended with great pain and swelling of the limb at first, and subsequently with abscesses, which lead down to the old bone, and afford issue to copious fetid suppurations. In some instances the old bone, which is called the sequestra, has been removed by a surgical operation, particularly in the tibia. Where this cannot be admitted, blisters dressed with savine, or issues, will remedy the irritation, and prevent suppuration, while the absorption of the old bone is going on. Leeches, cupping, &c. may be required, if inflammatory symptoms manifest themselves. Sometimes amputation is necessary, particularly in poor persons, whose circumstances will not admit of delay.

Exfoliation is the term applied to the death of a small portion of bone, in which generally the surgeon must wait until nature has separated the dead part.

Caries is a disease of the substance of a bone, causing foul, ill-conditioned ulcers, and attended with occasional exfoliations. Means which reduce inflammation are proper at first; followed by counter irritation.

Rickets is a disorder consisting in a flexibility of the bones, and, consequently, a deformity of the part affected, occurring ge-

nerally in weak children. The constitution should be strengthened, and mechanical means will often in an early stage have considerable effect in restoring the deformed part.

Fractures are either simple or compound. The former are usually attended with a distortion of the limb, with a grating or crepitus perceptible on rubbing the broken ends against each other, with pain and swelling, and often with spasms of the muscles. The accident is remedied by the effusion of a soft vascular matter between the broken ends, and by the gradual deposition of earth in this, where it acquires a sufficient firmness to admit of the part being used again at various periods, from three to seven weeks. The new matter is called callus. The treatment must consequently, consist simply in bringing the limb into its natural position, and retaining it there firmly, until the union is accomplished. In effecting the former object, some force is often necessary where the muscles have shortened the limb, as is frequent in the thigh, and this is termed extension. The latter end is attained by means of instruments called splints, which are firmly bound on the broken limb, including generally the joints, which connect it to the neighbouring parts, and which of course must vary in their form, &c. according to that of the part on which they are placed.

Compound fractures are those in which there is an external wound, made by the broken bone, which generally protrudes through it. Here the violence suffered by the limb is much greater, inflammation of the surrounding parts, extensive abscesses, exfoliations of the broken ends, and great constitutional sympathy, may be naturally expected. Where the injury is very violent, the bone much shattered, and the soft parts lacerated considerably, immediate amputation may be performed. Otherwise close the external wound, lay the limb in its natural position, and keep it so, and pay strict attention to the constitution. Extensive abscesses, &c. may render amputation necessary at a subsequent time.

Dislocations, or luxations, are the displacements of the articular surfaces of bones, by external violence. Hence their symptoms arise from the altered form, and impaired functions of the parts. The head of a bone is out of its natural socket, and is lodged in some unnatural situation, the limb cannot be moved by the patient; there is great pain, aggravated by the surgeon's examination. The bone must be restored by means of force, to its proper place, and the limb kept quiet, until the effects of the violence are gone off. Compound dislocations must be treated on the same principles as compound fractures. Sawing off the end of the bone is quite unjustifiable in any case. If a luxation be unreduced for a few weeks, the bone in general cannot be replaced, and the patient becomes crippled. Dislocations are sometimes produced by diseases of the joints, destroying the ligaments.

PARTICULAR SURGICAL SUBJECTS.

The great number of these, and the limits prescribed by the nature of this work, render it necessary for us to pass over several, and attend only to the more important.

Injuries of the head. Fractures of the skull are not dangerous in themselves, but they indicate that considerable violence has been inflicted. We must guard against inflammation of the contents of the cranium; and continue the antiphlogistic regimen for three or four weeks. If the bone be even slightly depressed, the same plan may be pursued. Bleeding from the arm or temporal artery, saline purges, and diaphoretics, are usual means.

Compression of the brain may be caused by fracture with depression, or from extravasation of blood under the skull. Its symptoms are insensibility, dilated and immoveable pupil, slow and labouring pulse, difficult and stertorous respiration. These demand the application of the trephine, for the purpose of elevating depressed bone, or removing effused blood. Compression may also be caused by suppuration of the dura mater. This happens several days after the accident, is indicated by peculiar symptoms, as pain, feel of tightness, and puffy tumour of the integuments, and demands the use of the trephine.

Concussion of the brain is an injury of that organ produced by the blow, independent of actual fracture of the skull. After the first stunning subsides, there is sickness, contracted pupil, a degree of sensibility and irritability, and free respiration. The patient gradually goes into a state of phrenitis. Copious and repeated bleedings from the temporal artery and arm, saline purges, low diet, &c. are the only means of safety, and must be followed up until the symptoms are subdued.

Trepanning consists in removing, by means of a circular saw, a portion of the skull, in or-

der to allow the elevation of depressed bone, or the evacuation of blood or matter. The scalp must be divided by an incision down to the bone, and the sides of the cut turned up; these are laid down again, and approximated after the operation. Trepanning is not to be performed merely because there is a fracture or depression; but only when symptoms exist, showing that the brain is suffering from pressure.

Tinea capitis, or scald-head, is a superficial ulceration of the scalp, covered by thick dry scabs. Cleanliness is the most essential part of the treatment. The scabs must be removed, the head kept closely shaved, and the ulcers dressed with the ung. picis cum sulphure, or ung. hydr. nitr. or lotion of kali sulphuratum. Alterative medicines must be given at the same time.

Hare-lip is a deformity existing from birth, attended frequently with a fissure in the jaw and palate. Its cure consists in paring the margin of the fissure, and bringing the edges into contact, where they are held by means of pins, and the twisted suture; which is a thread passed over the pins in the form of the figure 8. They thus unite by the first intention. It should not be performed on very young children, as they are less manageable, and are liable to convulsions. The removal of the edge of the fissure is performed by means of forceps, by which the lip is held firmly, leaving out the part which is to be cut off, and which the surgeon removes at one stroke of the knife.

The same operation is necessary for cancerous ulcers of the lip, which commence in ulcerated, wart-like excrescences, and spread very destructively. They should be removed as soon as we can ascertain that they do not yield to our remedies.

Diseases of the antrum are inflammation and suppuration of that cavity, and fungous growth from its surface. The former requires an opening by the extraction of one of the grinders, and the introduction of a pointed instrument through the socket. In the latter the cavity should be trephined, and the fungus removed.

The *noli me tangere*, or spreading herpetic ulcer about the nose, is a very intractable complaint. Alterative medicines should be given internally, together with cicuta, and even arsenic: ung. hydr. nitr., ung. picis., solution of lunar caustic, and of arsenic, as topical applications.

Fistula lachrymalis arises from obstruction of the ductus nasalis, which causes a swelling in the corner of the eye, flux of the tears over the cheek, and afterwards a fistulous opening from the lachrymal bag. Its cure, in an early state, is by injecting warm water through the puncta, using a collyrium of white vitriol, and smearing the edges of the eye-lids with ung. hidr. nitr. In a more advanced state, an incision into the lachrymal bag is required, together with a forcible removal of the obstruction, and the introduction of a straight silver nail-headed style.

DISEASES OF THE EYELIDS AND EYES.

Psorophthalmy and *lippitudo*, or inflammation of the edges of the eyelids, with itching, &c. Ung. hydr. nitr. lowered, rubbed on at night with camel-hair pencils; vitriolic collyrium, and alterative medicines.

Purulent ophthalmy. Red, swollen, and everted state of the eyelids, with discharge of purulent matter, particularly in children. Inject under the eyelids solutions of camphor, or the metallic salts.

Ectropium, or eversion of the eyelids, followed by an indurated and callous state of the conjunctiva. Remove a portion of that membrane. Exactly the reverse of this is the *trichiasis*, or inversion; where the hairs rub against the eyeball, and where a portion of the skin of the eyelid must be removed. *Hordeolum*, or stye, requires an emollient poultice, and touching with argentum nitratum.

Ophthalmy, or inflammation of the eye, distinguished into the first, which is called the acute stage, attended with heat, pain, fever, &c. and the second, or chronic period, in which there is a weakness of the organ. Remedies of the first are; in slight cases, low diet and gentle purging, with keeping off the light: afterwards, in the chronic state, one of the following collyria. ℞ Zinc. vitriolat. gr. v. Aqu. Rosæ, ℥ iv. ℞ Ceruss. acet. gr. viii. Aq. fœniculi ℥ vi. Spt. vin. camph. gtt. x. In more severe cases, general and local bleeding; blisters to the temples, behind the ears, and to the nape of the neck; warm emollient applications to the eye, total darkness, and the antiphlogistic regimen in every respect. Where the chronic state has commenced, astringent collyria, or the tinct. thebaica, dropped once or twice a day between the eyelids. When the complaint is very protracted, the state of the constitution in general, or of the digestive organs in particular, often is the cause; hence alterative remedies, attention to regularity of the bowels,

pure air, exercise, &c. become necessary.

Opacity of the cornea, varying in extent or intensity, and hence divided into nebula, albugo, leucoma, &c. often accompanied with varicous vessels in the conjunctiva. Collyria of corrosive sublimate; ung. hydr. nitr. to the opaque part, touching it with argent nitr.; cutting the enlarged vessels of the conjunctiva. Ulcers of the cornea should be touched with argent. nitr.

Pterigium is a reddish, loose, triangular membrane, growing over the cornea; and must be removed by an operation.

Staphyloma is a protrusion of the cornea between the eyelids, consequent on various affections of the eye, and always attended with entire destruction of the organ of vision. Cut away the projecting part, in order that the globe may collapse.

Prolapsus of the iris through a wound or ulcer of the cornea; if all the inflammation has subsided, touch the tumour repeatedly with argent. nitrat. until it is destroyed.

Hypopyum is the collection of a yellow purulent fluid behind the cornea, consequent on inflammation of the eye. If the ball should seem much distended, an opening may be made for its discharge; otherwise attend only to the complaint which causes it.

Dropsy of the globe terminates in protrusion of the organ through the eyelids, ophthalmy, and destruction of the part. The projecting cornea may be cut away, that the distended globe may collapse.

Cancer of the eye should be treated by extirpation of the organ, as soon as the disorder is recognized. The outer angle of the eyelids may be divided to give room; these parts should be preserved, unless included in the disease; and care must be taken not to penetrate the thin walls of the orbit in the operation.

Gutta serena, or *amaurosis*, is a paralytic affection of the optic nerve, inducing blindness: it may be either complete or incomplete; inveterate or recent; continued or periodical. The iris is immoveable, and the pupil dilated; there is strabismus; insects, or loose substances, seem floating in the air before the complaint is formed. The incomplete recent form of the disease is most frequently curable; the complete inveterate amaurosis seldom admitting of cure. The former generally arises from disorders in the primæ viæ, and should be treated with emetics, and the following pills: ℞ gum. sagapen. galban. sap. ven. ā ā ʒ i. Rhei ʒiss; antim. tart. gr. xvi; succ. liq. ʒ i. M. fiant pilulæ granor. v. Three to be taken morning and evening for six weeks. Bark, pure air, &c. must be resorted to afterwards. Such cases as arise from organic injury, or disease of the part, or are attended with exostoses of the neighbouring bones, or with acute and continued pain in the head and eye-brow, &c. afford little hope of success. Electricity has sometimes succeeded.

Cataract is an opaque state of the crystalline lens, inducing blindness. Its attack is gradual; a slowly-increasing mist surrounding all objects. The pupil becomes opaque, and these symptoms proceed to an almost entire loss of sight, and milky whiteness of the pupil. A power of distinguishing light from darkness however generally remains, and the iris still contracts on exposure to light, which two circumstances distinguish the case from amaurosis. It has been divided into the hard, soft or caseous, and milky or fluid kinds, according to its consistence; but these cannot be recognized before the operation. The case is often complicated by the co-existence of other affections, as chronic ophthalmy, lippitudo, gutta serena, adhesion to the iris, &c. It comes on spontaneously, and the only mode of treatment is by a surgical operation; the lens may be taken out of the eye by a cut in the cornea, or it may be moved backwards and downwards in the vitreous humour, so as to be removed from the axis of vision; the former operation is called extraction, and the latter couching. A favourable case for the operation is where the eye retains its sensibility to light; where there is no head-ach nor ophthalmy; no adhesion to the iris. If amaurosis accompany the cataract, the operation would be of no use.

Couching is performed by means of a sharp-pointed, slender instrument, called the couching needle, introduced into the globe of the eye, about one eighth of an inch behind the cornea, carried in front of the cataract, and then moved downwards and backwards, so as to displace the opaque lens from the axis of vision. The cataract will be absorbed in time, when it is thus removed from its natural connections. If the lens should be in a milky or caseous state, the pupil will not become clear at the time of the operation, but the opaque fluid, or any fragments, will be absorbed afterwards. If there be adhesion to the iris, beware of too much violence, and rather repeat the operation. Needles have been

made of various shapes; those of Mr. Hey and Scarpa are the best.

Extraction is performed by cutting the lower half of the cornea, near its junction with the sclerotica, with a slender knife carried across the eye by one motion of the hand. A scratch is then made in the crystalline capsule, through which the cataract escapes. The dexterity required in performing extraction, and particularly in making the cut through the cornea, is only to be acquired by long practice; and this operation has consequently become confined almost entirely to the oculists.

Much has been written on the respective advantages of the two operations: the merit of ease of performance, simplicity, and mildness in the subsequent symptoms, belongs to couching; also that of the power of repeating the operation. Extraction is more difficult, attended with greater injury to the eye, and consequently greater inflammation, but it removes the cause entirely.

After both operations light must be carefully excluded, and every precaution taken against inflammation. The use of convex glasses is required as an assistance to the sight, rendered necessary by the loss of the lens.

The capsule of the lens sometimes becomes opaque after the operation, and thus a secondary membranous cataract is formed, requiring the operation.

DISEASES OF THE MOUTH.

Ranula is an indolent tumour, formed under the tongue, consisting of a membranous cyst, containing a fluid generally like white of egg, and occasioning no inconvenience until its bulk becomes troublesome. If punctured, it will collect again. Cut away that surface of the bag, which projects, and rub the remainder with lunar caustic. Tumours under the tongue may be entirely removed; and calcareous concretions in the ducts must also be cut out.

Shortness of the frenum of the tongue, causing a preternatural confinement of the organ, may be remedied by dividing it to the requisite extent with blunt scissars.

Ulcers of the tongue may arise from the rugged edge of a tooth, which should be made smooth; from the use of mercury, when pushed to salivation; from disorders of the primæ viæ, foul state of the stomach, &c. in which case emetics, and afterwards alterative medicines, are required. They may, lastly, be of a cancerous nature, commencing in a small scirrhous tumour, or an induration of the substance of the tongue, and accompanied with hard irregular edges, and foul discharge. This cancerous state of the organ will end inevitably in a miserable death, unless an operation for the removal of the disease be performed. This may be accomplished by the bistoury, or by a double ligature passed through the substance of the organ, and tied so as to include the disease. If the glands under the jaw have been affected, it is too late to operate.

The *tonsils*, when inflamed, sometimes swell so as to impede deglutition and respiration, particularly when abscesses form in the neighbourhood. They may be scarified freely by the pharyngotomus (which is a lancet contained in a sheath); and the same instrument may be employed in opening collections of matter. An indolent enlargement of the tonsil may be remedied by cutting away the projecting portions by means of a hook and bistoury; or by means of ligature.

The *elongated uvula* requires astringent gargles, or the removal of its extremity by scissars constructed for the purpose.

AFFECTIONS OF THE NECK.

The wounds of this part, inflicted in attempts at suicide, often require the surgeon's assistance. After stopping any bleeding vessels, let the wound be approximated by bringing the head forwards on the neck, and retaining it in that position. Sutures, placed in the trachea, cause great and very detrimental irritation: yet if the tube be cut completely through, and position alone will not bring the ends together, a suture should be placed, so as not to affect the lining of the tube. If the œsophagus be wounded, a hollow bougie should be introduced through the nose, for the purpose of conveying nourishment into the stomach; and this may even be necessary when the trachea alone is injured. Inflammation may require bleeding, and the antiphlogistic plan. If there be cough, almond emulsion, with opium, will afford service. Foreign bodies, lodging in the œsophagus, may be either thrust down into the stomach, or drawn upwards through the mouth. The former plan may be pursued with those which can produce no harm when in the alimentary canal; the latter with such as might prove hurtful from their hardness, indissolubility, pointed angular shape, &c. Indeed bodies of the latter description, if very low down, must still be pushed on into the stomach, as they hardly admit of extraction. When the substance

is near the throat, a curved pair of forceps may remove it; there is also an instrument made of strong flexible wire doubled and twisted together, and bent at the end into a noose, like a hook; and other mechanical contrivances have been suggested. A common probary probably is the best instrument for pushing bodies onwards to the stomach, which must be done, whatever their nature is, when they cannot be got out, and produce troublesome symptoms. Often they are loosened, after a time, by suppuration, if small; or they may be discharged by abscesses; or, as pins and needles, may traverse parts of the body, and appear at a considerable distance.

Bronchotomy is an operation in which an opening is made into the trachea or larynx, for the purpose of inflating the lungs, in cases of suspended animation; for the continuance of respiration, when the natural passage is obstructed by disease; or for the extraction of foreign bodies from the trachea. In instances of apparent death, from drowning, &c. it is our first object to restore respiration; the suspension of that function has caused the stoppage of the other actions, and its restoration is essential to the putting of the animal machine again in motion. If this cannot be done by the means laid down in the article DROWNING, the simple operation which we shall describe may be performed. Again in diseases or tumours about the throat or trachea, and in cases where suffocation is threatened by a foreign body in the latter tube, the same remedy is necessary. A longitudinal incision of two inches should be made in the middle of the neck, commencing just above the sternum, and continued upwards; the parts should then be separated with the finger and handle of the knife, so as to expose the trachea, which may be opened by a longitudinal cut of half an inch. Some have advised this operation to be performed by a transverse cut, between the thyroid and cricoid cartilages; and others by a longitudinal incision in the projecting part of the thyroid, called pomum Adami.

Wry Neck, is a deformity in which the head is drawn towards one of the shoulders; arising either from undue contraction of the sterno-cleido-mastoideus, (whose fibres will be found in a very tense state) or from a relaxation, or paralytic condition of the opposite muscle. Perhaps cicatrices from wounds may sometimes be a cause. If it occurs in early life, and continues long, the vertebræ of the neck, and even of the back, may become deformed.

Treatment; camphorated mercurial frictions, and other stimulating applications; electricity, blisters, issues, mechanical means being at the same time employed: this plan is more particularly proper when there is induration. Division of the clavicular portion of the muscle, by a surgical operation, is most to be depended on.

Bronchocele, is an indolent enlargement of the thyroid gland, the causes of which are unknown, but which often attains an immense magnitude, and is endemic in several mountainous countries, as Switzerland, Savoy, Derbyshire, &c. Burnt sponge, in the dose of a scruple, two or three times a day, formed with syrup into troches, which should be placed under the tongue, and allowed to dissolve gradually, is the most certain remedy for this disease. Previously to commencing this plan, a grain or two of calomel should be given at bed-time for three nights, and a dose of the magnesia vitriolata on the following morning. This should be repeated again in three weeks, the sponge being then omitted, and the same alternation should be observed during the cure. Topical means may be combined; as friction with a dry towel, or camphorated liniments, &c.

Wounds of the Thorax. Much probing should not be employed to ascertain whether the cavity is penetrated or no, as symptoms will best indicate this point. Passage of air from the cavity, or protrusion of the lung, are appearances which show immediately that the cavity is exposed.

Emphysema is an inflation of the cellular substance, commencing at the chest, and extending over the whole body, arising from a wound of the air-cells of the lungs, and generally produced from broken ribs, or narrow punctured wounds: for, in either of these cases, the air, which issues from the wounded lung in inspiration, has no external discharge, as in instances of large and open wounds. It is surprising to what extent this inflation may proceed, and as the lung at the same time collapses, the greatest distress is experienced in breathing: yet the swelling of the body is not the dangerous part of the case. Our object is to give a free exit to the air, which may be done by a cut near the injured part, and even, if symptoms require it, into the chest. The air may be discharged from other parts by incisions through the skin, and pressing towards the wound. In about three or four

days, the wound in the lung heals, and the air in the chest and cellular substance is absorbed. Bleeding, and other parts of the antiphlogistic regimen, must be used without restraint. Bandages on the chest generally increase the distress.

Wounds of the lungs are indicated by the coughing of blood, by the discharge of that fluid, with air, from the wound, impaired respiration, &c. Though they are often very speedily mortal, yet patients have, in many instances, recovered. The freest use of the lancet is required, with every other part of the antiphlogistic treatment; perfect rest; light dressing of the wound, which must not be probed. Paracentesis thoracis is required, where it appears that water, air, blood, or pus, are accumulated in the cavity, and give rise to danger by their presence. When there are symptoms indicative of these circumstances, the operation is easy; and it may be done, unless the circumstances point out any other spot, between the sixth and seventh true ribs about midway between the sternum and spine. The integuments should be drawn aside before the first incision, that the opening may be valvular. After cutting about two inches through the skin, dissect down cautiously to the pleura, keeping close on the upper edge of the rib; when a small puncture is made in the pleura, it may be enlarged to the requisite extent with the director and curved knife.

Removal of a diseased breast. In this operation, and in the extirpation of tumours in other parts, the surgeon must attend carefully to remove all the disease; hence integuments should be included, when they deviate at all from the healthy condition; and the pectoral muscle should also be taken away, if the tumour adheres to it, as far as it may have become indurated. In all cancerous complaints it is most advisable to extend the incision even beyond the seat of actual disease; as a morbid disposition may have been formed, and would lead to the reproduction of the disorder. Where the skin does not participate in the disease, its removal is unnecessary; the first incision, therefore, may be a simple cut in such a case; while in others two semicircular cuts should be made, meeting at their extremities in acute angles. The tumour should then be separated all round from the surrounding parts; and lastly, the base is to be detached from its connections from above downwards. The cut surface should then be carefully examined, to see if any indurated parts have been divided; for in that case some portions have been left behind, and ought to be taken away. Arteries may be tied as they are divided, if they bleed profusely. When enlarged glands in the axilla require removal, the incision must be extended in that quarter, and the indurated parts completely removed, caution being necessary, on account of the proximity of the large vessels and nerves. When the hemorrhage is stopped, the sides of the wound must be brought together by sticking plaister.

Wounds of the abdomen. These may, or may not, injure the contents of the cavity; but the mere circumstance of their penetrating it constitutes a source of great danger, from the peritoneal inflammation which is likely to ensue. We may not be able to discover whether the cavity is exposed or no; but this is of no consequence. A small, feeble, and contracted pulse; pallid countenance; coldness of the extremities; great and sudden debility; hiccough; vomiting; and tension of the abdomen; show that some important parts are injured. A bloody state of the urine; discharge of blood by vomiting and stool; escape of urine, feces, or chyle, by the wound, indicate to us what particular parts are included in the injury. A protrusion of the viscera is a frequent attendant on these cases. The subsequent occurrence of the symptoms described as belonging to peritonitis (see MEDICINE) is the natural consequence of the injury, and brings the greatest danger to the patient.

The *treatment* divides itself into two parts; as regarding the wound, and the constitution in general. An over anxiety to discover the extent of the wound, and the parts injured, is useless and reprehensible; if these facts cannot be made out with facility, the surgeon must be contented to remain ignorant of them. Protruded parts must be immediately restored in the most gentle way, and the wound may probably require dilatation for this purpose; which the surgeon may accomplish with the probe-pointed curved knife, guided by his finger or a director. Fomentation of such parts is perfectly useless. A discoloured state of intestine is no reason why it should not be replaced, if it looks very suspicious it may be retained near the wound by a suture through the mesentery. If the gut be wounded, three simple stitches may be made at three different parts of the circumference, and the part retained near the

wound. To attempt to unite the edges by making them touch at every point, would be obviously nugatory. The ensuing inflammation agglutinates the gut to the surrounding parts, and thus the breach becomes gradually closed, while the extravasated matter readily escapes through the wound, behind which the injured part is confined. If the wounded portion of the gut be within the cavity, we must trust to the powers of nature, observing only to facilitate the discharge of the intestinal contents. Sometimes in such a case a perfect cure is obtained; sometimes the feces are discharged for ever after through the wound, and sometimes a fistulous opening remains. Should the return of a large piece of omentum be very difficult, it may be cut off, and any bleeding vessels secured. The wound should then be accurately and firmly closed by means of sticking plaister, aided by an attention to position, which is much better than using sutures. The introduction of tents is a part of the old practice, contrary to all principle, and therefore universally exploded. The general treatment of the patient requires a strict observance of the antiphlogistic plan; perfect quiet, abstinence from animal food and fermented liquors, and mild purgatives should be employed in every case; and where symptoms of inflammation exist, even although the pulse should be small, copious bleeding from a large orifice is absolutely necessary. Cupping or leeches to the abdomen, followed by fomentations and blisters, will also be necessary.

Gunshot wounds of the abdomen are very seldom attended with protrusion of the intestines. The treatment is here limited to the employment of general means, which have sometimes the happiest effect under very unpromising circumstances.

Wounds of the abdominal viscera are often attended with extravasation of various substances into the cavity: these may consist of intestinal contents, bile, urine, or blood. Besides the swelling which they cause, their presence irritates the surrounding parts, producing inflammation, constitutional disturbance, and sometimes even suppuration and a manifest fluctuation. If bile or urine be effused, the symptoms come on very rapidly, and are extremely urgent; but in other cases the symptoms are not so pressing. The resistance arising from the pressure of the respiratory muscles occasions the effused matters to be collected into one mass, and prevents them from becoming generally diffused over the cavity. When swelling, attended with local pain, fluctuation, &c. and the other symptoms which will attend the case, clearly indicate a collection of this kind, it may be opened by the surgeon.

Psoas abscess is a collection of matter behind the peritoneum, in the cellular substance surrounding the psoas muscle. It forms in a very gradual manner, generally without inflammatory or febrile symptoms. There is a dull pain in the loins, and a slight weakness of the affected thigh. After some time, the matter descending by its own weight, passes Poupart's ligament, and forms a swelling in the groin; or it may present in the back just under the last rib. At this period the motions of the thigh are considerably impaired, particularly those, in which the psoas muscle is concerned. There is an impulse in the tumour, when the patient coughs, and the swelling is larger in the erect position. Sometimes disease of the vertebræ accompanies this affection. When the abscess bursts, the whole cyst falls into a state of inflammation; violent irritative fever ensues; and there is copious suppuration, under which the patient gradually sinks. The most successful plan hitherto adopted, is that of opening the abscess, as soon as it has presented fairly, by a pretty free incision with the abscess lancet; bringing the wound together, without allowing the introduction of any air, and closing it accurately with sticking plaister.

This is to be repeated when the matter has accumulated again, and thus the contraction of the cyst will be promoted; a third and fourth puncture may be necessary. Electricity and emetics of the metallic salts may be combined with this plan to favour the absorption of matter; and a blister kept open by the savine cerate will be an useful auxiliary means. Disease of the bone requires blisters or issues in the loins.

Paracentesis abdominis is an operation performed for the discharge of dropsical fluid, and consisting merely in penetrating the parietes of the cavity by means of a trocar. The instrument is to be introduced three inches below the navel, in a perpendicular line drawn from that spot; and it should not be pushed more deeply, when it meets with no further resistance. Pressure by a belt or the hands of assistants should be kept up during the evacuation, as faintness is frequently produced

by the sudden removal of the support from the abdominal viscera.

HERNIA

Is a tumour formed by the passage of any of the abdominal viscera from the cavity in which they are naturally contained, into a preternatural bag, formed by the protrusion of the peritoneum. The protruded portion of peritoneum is called the hernial sac. This peritoneal sac is covered by another investment of various degrees of thickness, consisting probably, in great part, of the surrounding cellular substance, condensed into a membrane-like appearance, by the pressure of the hernia; in the same way as tumours acquire their investing cyst. In the inguinal hernia this external coat of the sac possesses some tendinous fibres in its structure, derived from the aponeurosis of the external oblique, where it forms the ring. The cremaster muscle is also expanded on its surface; it consists usually of several layers, the division of which, in the operation, often leads the surgeon to suppose that he has opened the hernial sac. Scrotal ruptures often descend to various distances on the thigh, sometimes indeed even to the knee; yet the whole inner surface of the bag, in which all the loose viscera of the abdomen may be contained, is lined by a continuation of peritoneum; indeed the hernial sac, taken altogether, is generally thicker and stronger in proportion to the size of the tumour, and to the duration of the complaint. The exterior covering is every where closely connected by cellular substance to the proper peritoneal sac. Hence the latter part is not returned into the abdomen, when the contents of the swelling are replaced, but remains behind ready to receive any future protrusion. When the parts have descended through the abdominal ring, the case is called a bubonocele, or inguinal hernia; if they are in contact with the testis it is termed congenital. The crural or femoral is that which takes place under Poupart's ligament; and the exomphalos, or umbilical rupture, occurs at the navel. The names of enterocele, epiplocele, and entero-epiplocele, are applied according as the swelling contains intestine, omentum, or both together. These are by far the most frequent forms of the complaint; yet there are several others, as ventral hernia, which takes place between the fibres of the abdominal muscles; hernia of the foramen ovale, ischiatic notch, &c. While the viscera descend and return freely, the complaint is said to be in a reducible state; but when from increase of bulk, preternatural adhesions, or other causes, they are incapable of being returned, it is termed irreducible. An incapacity of reduction, arising from stricture in the opening, through which the viscera have descended, brings it into the incarcerated or strangulated state. The causes of hernia are of two kinds; the occasional, or exciting, which consist of all those, by which the pressure of the abdominal viscera against the sides of the cavity is increased, as in straining, and all forcible actions of the respiratory muscles; and the predisposing, which favour the occurrence of rupture in particular individuals, as an unusually large state of the openings, or lax condition of the margins of those apertures.

A *reducible hernia* is an indolent tumour, smaller in the recumbent position, larger in the erect posture; diminishing, or entirely disappearing by means of pressure; large and tense after a meal, or when the patient is troubled with wind, soft and small in the morning, before he has taken any food; attended occasionally with a rumbling sensation, particularly on its return, and rendered tense when the patient coughs, so as to communicate an impulse to the hand of the examiner. Various visceral derangements, as colic, constipation, and vomiting, are occasionally attendant. Uniformity and elasticity of the tumour, together with the rumbling noise, and the feeling of impulse on coughing, show that the case is an enterocele; but if the swelling be compressible, flabby, and uneven, free from tension on coughing, and slow in returning, the contents are omentum.

A reducible hernia, although not immediately dangerous, leads to many unpleasant consequences, from its constant increase in size, and the visceral derangements that ensue from this cause. It is also constantly liable to strangulation.

In a *strangulated hernia*, the protruded parts become inflamed, and this affection is propagated over the rest of the surface of the abdomen. Hence pain of the part, and tension of the belly, are early symptoms. An entire suppression of the fecal discharge is also a very leading character. Nausea and vomiting ensue; all the contents of the stomach, and afterwards those of the intestines, down to the stricture, being rejected. The whole system is deranged; there is great anxiety and restlessness, with a small and hard pulse, and cold extremities. At length hiccough supervenes, the pulse is hardly sensible, the respiration weak, and the whole body is

covered by a cold and clammy sweat. Mortification and death now speedily succeed. The intensity of the symptoms and their duration before the occurrence of the fatal event, are modified by numerous circumstances, as the age and strength of the patient, size of the rupture, closeness of the stricture, &c.; so that a case may terminate fatally within twenty-four hours, or it may be protracted for two or three weeks. Hence the strangulation has been distinguished into the acute and chronic.

The *treatment* of a reducible rupture comprehends the return of the protruded parts, and their retention within the abdominal cavity by means of an appropriate truss. Various proceedings were recommended by the older surgeons for producing a radical cure, as castration, caustic, the royal stitch, &c.; but as these expose the patient's life to the most imminent risk, without affording any greater chance of an effectual cure than the use of trusses would bestow, they have gone entirely into disuse. Herniary bandages are of two kinds; the elastic and non-elastic. The former are constructed with a piece of steel nearly encircling the body, and termed the spring, by means of which they maintain a constant pressure on the opening, through which the parts protrude.

If their use be continued for a sufficient length of time, it even affords a prospect of a radical cure. Since the constant pressure of the pad of the truss keeps the neck of the sac empty, and thereby brings on a gradual contraction and obliteration of its cavity. Non-elastic trusses are so inferior to the others, that they are now universally laid aside. As the best constructed trusses will not afford a certain protection from descent of the bowels, the ruptured person should avoid all great bodily exertions; and, if the hernia should descend, he should immediately go to bed and send for surgical assistance.

As an *irreducible hernia* does not admit of the employment of a truss, the tumour must be supported by a suspensory bandage, and the patient, by temperance in diet, constant attention to the state of his bowels, and avoiding all great exertions, must endeavour to obviate the risk of strangulation, to which he is constantly exposed, and to prevent the increase of the tumour. Confinement to bed for a few weeks, with bleeding, mercurial medicines, purges, and low diet, has sometimes caused irreducible hernia to go up; but great caution is necessary in adopting such a plan.

In the *treatment* of strangulated hernia we attempt first to replace the protruded parts; which operation is technically termed the taxis. The patient should lie down, with his pelvis placed higher than the shoulders, with the thigh, in inguinal and crural hernia, bent and rolled inwards; the bladder being previously emptied, and a caution being given to abstain from coughing, holding the breath, &c. Gentle pressure must now be made on the tumour, and increased to a certain extent, but, if possible, not so as to give pain. A general pressure may be made with both hands, or the tumour may be grasped with one, while the other is placed at the aperture, and employed in facilitating the entrance of the parts, or in keeping up those which have been already returned. The pressure should be exerted according to the course in which the parts have been protruded; *i. e.* upwards and outwards in the bubonocele, backwards and then upwards in the femoral hernia. Small herniæ are the most difficult of replacement; and the taxis succeeds also oftener in the early than the later periods of strangulation. It should not be persevered in when the rupture becomes painful. Mild purgatives and clysters should be used, even if the taxis succeeds. When we have not succeeded in replacing the parts, various means may be adopted in the treatment of a strangulated rupture. Those which are the most to be relied on are, bleeding, the warm bath, clysters of the decoction or smoke of tobacco, and ice or other cold applications to the part. The former remedy must not be used indiscriminately, nor without a due attention to the patient's age and strength, nature of the symptoms, &c. Yet it should be employed with vigour when we have resolved on its use; and a considerable quantity should be drawn suddenly from a large orifice to induce fainting. This, with the warm bath, and the employment of ice, or of the freezing mixtures, made by the solution of salts, are the means to be employed first; and if they fail, the tobacco clyster made by boiling one dram of tobacco for ten minutes in a pint of water, should be instantly tried. If this does not succeed after two or three attempts, the operation must be performed without delay. A smart purge of calomel and jalap will sometimes succeed in the early stage of strangulation, particularly in old and large hernia, where

disorder of the bowels may have been the cause of strangulation, and where the symptoms are not very urgent. Opium is of use to allay the sickness. The surgeon should act with the greatest decision in these cases, and should particularly avoid all unnecessary delay. He should try at once the most powerful means, and operate as soon as it is found that they will not succeed. Surgeons are now universally agreed, that the danger of the operation arises chiefly from its being deferred until the local or general disturbance have proceeded to such a height, that a favourable result can hardly be expected; and that the chance of recovery is very considerable when it is performed under more favourable circumstances. We shall describe the operation in speaking of inguinal hernia.

Inguinal hernia. The spermatic chord in the male subject, and the round ligament of the uterus in the female, pass through a canal in the lower and front part of the abdominal muscles, called the abdominal ring. This canal is oblique in its course, commencing at the mid space between the spine of the ilium and angle of the pubes (upper or internal aperture), running downwards and forwards, and terminating just over the pubes (lower, or external aperture). The upper opening is formed in a fascia, which ascends from Paupart's ligament, behind the abdominal muscles, and it is crossed above by the under edge of the internal, oblique, and transversalis muscles; the lower opening is formed by the tendon of the external oblique alone, and the distance between these is about two inches and a half. The inguinal hernia generally descends directly over the spermatic chord, which is consequently placed just behind the hernial sac; but it sometimes comes out directly from the abdomen, through the tendon of the external oblique, without traversing the canal of the abdominal ring, and here consequently the spermatic chord is on the outer side of the rupture. In the former, and most frequent case, the epigastric artery runs along the inner edge of the mouth of the sac, while in the latter its course is on the outer side of the same part. The stricture may be situated, either at the upper or lower aperture of the ring, or in both.

Besides the common symptoms belonging to all herniæ, there are certain local characters which designate this species. The tumour descends from the abdominal ring to various distances in the scrotum, appearing first in the groin, and passing downwards in front of the spermatic chord. The testicle may be felt below or behind the swelling, which always appears to extend into the ring, and is hence distinguished from most other affections of these parts. It is much more frequent in the male than in the female subject. It must be distinguished from hydrocele, varicocele, sarcocele, hernia humoralis, and bubo.

In operating for bubonocele, the patient's thigh should be bent, and the hair shaved from the swelling and neighbouring parts. An incision should be carried through the integuments from an inch above the ring to the bottom of the tumour. The cellular substance intervening between the skin and hernial sac is then to be divided, layer by layer, with the knife and dissecting forceps; and the sac itself should then be opened with the edge of the knife held horizontally. A small portion of fluid is usually discharged at the aperture, which must be enlarged so as to expose the whole tumour. The stricture, in whatever part it may be situated, must now be divided by the probe-pointed knife, conducted by the finger or director, and carried directly upwards, so as to cut the middle of the upper part of the contracted portion. This incision, which is technically named the dilatation of the ring, should not be carried further than is absolutely necessary for returning the parts. If the protruded parts are sound, and not adherent to each other, nor to the sac, they may be immediately replaced, the limb being alway bent and rolled inwards in this part of the operation, to relax the opening as much as possible. Intestine, although very much discoloured, will recover when replaced in the cavity. If any adhesions exist, they must be destroyed by the knife, or finger if they are not strong. The omentum is often found in a state in which it would be improper to return it. This viscus becomes thickened and hardened in an old hernia, so that its return would require a very free incision of the ring, and it is often discoloured by the inflammation consequent on the strangulation. In all such instances it should be cut away as far as it is affected, and the remainder returned into the abdomen, after any bleeding vessels have been secured by fine ligatures. The practice of tying the omentum in a mass previously to cutting it off is very pernicious, and has often been fatal. The wound should be closed by sticking plaster, assist-

ed, if necessary, with one or two points of suture. Common clysters, and mild purgatives, such as manna and Epsom salts, dissolved in mint water, should be taken after the operation, and the strictest regimen observed until the recovery is complete. Peritoneal inflammation, which is not an unfrequent consequence, must be treated by the most vigorous antiphlogistic means, of which copious and repeated venesections are the most important.

The operation above described would not be suitable in a case of large and old rupture. The extensive surface which must be exposed, and the violence necessary in separating adhesions, give rise to so much inflammation, that the consequences would be much dreaded, and the bulk of protruded parts has been sometimes so great, that they could not be retained in the belly after the operation. Here then the surgeon should take off the stricture without opening the sac, and push back as much of the contents as will pass up readily.

When mortification has taken place in the contents of a rupture, our conduct must be adapted to the circumstances of the case. It is sometimes found to have occurred in the protruded parts, when no sympton had previously led the surgeon to suspect it. But the mortification generally spreads to the superincumbent parts the swelling becomes soft, the integuments deep red, livid, and afterwards black, the cellular membrane is emphysematous, the pulse sinks, lastly, the integuments give way, and wind and feces are discharged. Although these cases are generally fatal, yet their event is sometimes fortunate. We must chiefly trust to nature, and be careful not to interrupt those processes which she employs for the restoration of parts. The intestine is adherent to the parietes of the abdomen behind the ring, these adhesions are of great importance in the subsequent progress of the cure, and should therefore never be disturbed. If the intestine has not already given way, we may remove the stricture: where an opening has taken place, we may make such incisions through the sphacelated parts as will provide a free exit for the fecal matter. In either case, mild purgatives and clysters will be proper to unload the bowels, and to determine the course of the feces towards the anus. The use of both these means with the latter object, constitutes a very important part of the treatment of all cases of mortified intestine.

In cases where the mortification has not gone so far, the protruded gut may be affected either in one or more small spots, or it may have become mortified through a greater or less extent of its whole diameter. In the former case it has been advised to leave the gut in the wound, after removing the stricture; or to return the intestine, and retain it in the neighbourhood of the ring by means of a ligature passed through the mesentery. The fear of an effusion of fecal matter into the abdomen, on the separation of the slough, formed the objection to the replacement of a mortified portion of gut and the intent of the ligature placed in the mesentery was to prevent the possibility of this much dreaded effusion, by keeping the sphacelated part opposite to the ring. Since, however, numerous facts have shown that neither of these events are to be expected, there can be no doubt as to the conduct required, where a portion only of the gut is affected with gangrene. We should replace it in the cavity with the mortified portion towards the wound, and await the result of the operations of nature without interference.

When the whole diameter has mortified, the excision of the dead part, and the introduction of the upper into the lower end of the gut, where it is to be secured by ligature, has been advised. We have also been recommended to keep the two ends near the ring, by ligatures in the mesentery. We advise, that after dilating the stricture, the subsequent progress of the case should be left entirely to nature. The sloughs will be cast off, the ends of the gut are retained by the adhesive process, in a state of apposition to each other, the most favourable for their union, the wound contracts, and often completely closes, so that the continuity of the alimentary canal is perfectly re-established. The interference of art can only be prejudicial in this process. Perhaps the only step which would be justifiable, is that of making an incision in the sphacelated part, this will promote the evacuation of the alimentary canal, and afford considerable relief.

In all cases of mortified intestine there is considerable danger of the feces passing off constantly through the wound, by what is called an artificial anus. Here we must endeavour to alleviate those distressing inconveniences which arise from the involuntary discharge of wind and feces through the new opening, by supplying the patient with an apparatus, in which these may be received as they pass off.

Femoral hernia is formed by the protrusion of some of the abdominal contents under the inferior margin of the external oblique muscle (which part is called also Poupart's ligament): and the swelling is situated towards the inner part of the bend of the thigh. It is much the most frequent in women, and is generally very small; hence it may be mistaken for a swollen gland, unless great attention be paid to the symptoms. The precise point at which this hernia descends is the space left under the crural arch between the femoral vein and the thin posterior edge of Poupart's ligament. The latter part has a broad insertion into the pubes, and this insertion ends in a thin and very sharp margin, turned towards the vein. The contents of the abdomen cannot escape in any other situation, because the crural arch is filled by parts going under it, and covered by a fascia extending over the iliacus internus muscle. The rupture first descends, and then comes forward, to which we must attend in endeavouring to reduce it. The peritoneal sac is covered by a very complete exterior investment, as in the inguinal species. The spermatic chord, or round ligament, passes directly over the mouth of the sac, and the epigastric lies on its outer edge. The stricture, which is always very close, should be relieved by detaching the thin edge of Poupart's ligament from the pubes.

Umbilical hernia, exomphalos, or omphalocele, is formed by the protrusion of the viscera through the tendinous opening termed the navel. An elastic truss for this rupture is described by Mr. Hey, and is the best hitherto contrived.

There is nothing peculiar in the treatment or operation, nor in those of the ventral and congenital kinds. The surgeon, however, in the latter will be aware that the hernial contents lie in the same bag with the testis, in consequence of the communication that exists in one period of the fœtal existence between the abdomen and tunica vaginalis testis never having been closed. Hence, in such a case, the testis cannot be felt distinctly from the hernial swelling.

Hydrocele is a collection of watery fluid in the cavity of the tunica vaginalis testis, or in the spermatic chord. The former is exactly similar in its nature to the dropsical affections of the peritoneum, pleura, or pericardium. The swelling is colourless, smooth, and pyriform; extending slowly and gradually upwards from the lower part of the scrotum; fluctuating and incapable of reduction or diminution; often there is a degree of transparency, so that the light can be discerned through it; but as the tunica vaginalis is frequently thickened, neither this circumstance, nor the fluctuation, can be entirely depended on. The testis cannot be felt, but the spermatic chord may be discerned clearly, in a natural state, above the swelling. The cure is either radical, or palliative: the latter consists in letting out the fluid with a trochar, after which a piece of soap plaister may be applied, and a bag-truss worn. The fluid accumulates again. In the radical cure, the hydrocele should be tapped with a trochar at its anterior and inferior part, and as soon as the fluid is entirely discharged, the cavity of the tunica vaginalis is to be distended to its former dimensions, with an injection composed of two parts of red wine, and one of warm water. The injection may remain in the part about five minutes, after which it is to be discharged through the trochar. The consequence of this treatment is a considerable inflammation of the part, terminating in the effusion of coagulating lymph, and the consequent obliteration of the cavity of the tunica vaginalis. The inflammation is to be treated like hernia humoralis, if it runs too high.

Hydrocele of the chord may either consist of an effusion of water into the cellular substance, or of a single cyst of various magnitude. If the former prove troublesome, a free incision through it seems to be the only means of treatment; the latter may be treated by the port wine injection.

Hæmatocele is a swelling of the scrotum, caused by the effusion of blood into the tunica vaginalis. Its most common cause is the wound of a blood-vessel in tapping a hydrocele: the water, as it flows off, is generally discoloured, and the swelling soon after regains its former magnitude. Discutient lotions, as that of the sal ammoniac, or cerussa acetata and vinegar, will generally cause the absorption of the blood; camphorated liniments and mercurial ointment may also be employed, if the case be obstinate. Should these means fail entirely, an incision must be made through the integuments and tunica vaginalis, and the blood removed.

Sarcocele is a chronic fleshy enlargement of the testicle. It exhibits very different appearances in different cases. It may present a vascular mass of uniform appearance, without enlargement of the chord, or any very painful symptoms. It may have a white caseous substance, intermixed with

this; or it may contain several cells, filled with different coloured fluids. But it is also liable to schirrus and cancer, in which case it forms a hard brownish mass, with portions of a membranous or gristly firmness intermixed, attended with severe pain darting along the chord to the loins, and having an unequal knotty feel. The chord too becomes enlarged, and the health is affected. Sometimes this kind of sarcocele forms a foul ulcer, with bleeding fungus, &c. When the chord is affected, the disease generally appears in the inguinal glands, and soon after destroys the patient. A mild sarcocele may be treated with leeches and discutient lotions, setons, and mercurial frictions, with the view of dispersion, but if these fail, castration is the only remedy. The same means should be immediately employed in a case of schirrus; for that affords no hope of cure. The operation would also be too late if deferred until the chord has become indurated and knotty. Chronic enlargements of the testicle are sometimes attended with an accumulation of limpid fluid in the tunica vaginalis, and the disease is then termed hydro-sarcocele.

The operation of castration consists in making a longitudinal incision from the abdominal ring to the bottom of the tumour; in dissecting down on each side of the spermatic chord, so as to be able to take it between the finger and thumb, in dividing the chord, and tying any bleeding vessels on its surface, and then in dissecting away the testis, by free sweeps of the knife, from the scrotum. All bleeding vessels should be carefully secured, the edges of the integuments retained by two or three points of suture, and in their intervals by sticking-plaster; over which a pledget, compress, and T bandage, are to be applied.

Varicocele is an enlargement of the veins of the scrotum, or spermatic chord, attended with a very peculiar feel, and causing a tumour, which is generally indolent, but may be troublesome. It is often mistaken for omental hernia; and sometimes is attended with wasting of the testicle. If the swelling be painful, leeches, saturnine and discutient lotions, purgative medicines, horizontal position, and a bag-truss, are proper. The varicous veins have been tied with success in very obstinate cases.

Hernia humoralis is an inflamed state of the testicle, in which that gland is much enlarged, and very painful. The scrotum is distended and red, and the pain shoots into the loins. Irritation of the urethra is the most frequent cause, and particularly that which takes place in gonorrhœa. The unpleasant symptoms of the latter complaint cease when the testicle swells, and often recur when the hernia humoralis abates. A recumbent posture, frequent application of leeches, saline purgatives, cold saturnine, or discutient washes, or in some cases poultices, and in all instances a suspensory bandage are the means of relief. Camphorated mercurial ointment should be rubbed on the epididymis, when a hardness of that part remains.

Cancer scroti, or chimney-sweeper's cancer, commences in the scrotum with an ulcerated wart, or rugged ill looking sore, with hard and elevated margin. It penetrates the scrotum, affects the testis, ascends along the chord, contaminates the inguinal glands, and terminates the patient's existence in a most deplorable way. Extirpation in the early state is the only effectual mode of treatment.

Gonorrhœa is the discharge of a mucous or purulent fluid from the urethra, occasioned by the application of infectious matter from another subject labouring under the disorder, and generally communicated by coition. The urethra may be irritated, so as to furnish a preternatural quantity of secretion, by other causes; as strictures, use of bougies, &c. It generally comes on from six to twelve days after the infection; and commences with an itching and fulness of the mouth of the urethra. A discharge follows, first of a watery and transparent kind, and then becoming thicker and white, yellow or greenish. The glans swells, and the membrane at the mouth of the urethra becomes smooth, red, and swoln. An acute scalding pain is experienced in making water, which is voided frequently, and in a diminished stream. Troublesome erections are experienced at night. Various sympathetic affections often attend; as pain and soreness over the whole pelvis, in the scrotum, testicles, anus, &c., enlargement of the inguinal glands, forming sympathetic bubo, and irritability of the bladder. It has been much disputed whether the matter of gonorrhœa and chancre be the same, and consequently whether the constitution can be affected from a gonorrhœa. But at present most surgeons are inclined to support the negative side of the question; and all act in the treatment of the complaint on this supposition.

In ordinary cases the affection does not seem to extend more than about two inches,

along the urethra. The complaint increases in violence for abont three weeks, and then gradually declines; a discharge often remaining when the other symptoms have entirely subsided, and being then termed a gleet. There is little power of stopping the course of the complaint, at least without great risk of inducing hernia humoralis; so that the safest plan is to palliate. Occasional saline purges, abstemious regimen, and copious draughts of diluting and mucilaginous liquors are proper with this view. Suspension of the testicles is useful as a precaution against hernia humoralis. Cold applications to the penis. After a few days, astringent injections may be employed, often with the effect of lessening the duration of the discharge considerably. Zinc. vitriol. gr. ijss. in twe ounces of water; or hydr. muriat gr. j. in eight ounces of water will do for the beginning; but their strength may be increased. Opium and antimony where the symptoms of irritation are very considerable; balsam. copaivæ is also very useful.

The gleet which remains after a gonorrhœa is not infectious, although very troublesome. Astringent injections may be tried for it; as hydr. mur. gr. ij. in aq. distillat. ℥ viii. or zincum vitriol. or cupr. vitriol. in larger proportions. Balsam copaivæ or tinct. cantharid. may be taken internally.

Chordee is an inflammation attended with extravasation of coagulating lymph into the corpus spongiosum urethræ, or corpora cavernosa penis, which renders the penis curved in its erect state. Bleeding by leeches, fomentations and poultices, with the antiphlogistic regimen generally; and afterwards camphorated mercurial ointment.

Sympathetic bubo should be treated as a case of common inflammation. Affection of the bladder may be combated by the warm bath, venesection, leeches, and fomentations to the perineum and bladder, and opiate clysters.

Phymosis and Paraphymosis. In the former the prepuce is so contracted, that it cannot be withdrawn over the glans; while in the latter it cannot be drawn forward from behind the glans. The irritation of chancres, gonorrhœa, &c. is the common cause of these affections; but some persons are born with a phymosis. Frequent injections under the prepuce are necessary in phymosis, which need not prevent the use of mercury if it is required. If the contraction be so great as to confine the matter, and absolutely prevent its discharge, the prepuce may be slit open, but not otherwise in the inflamed state. When the complaint has subsided, and the contraction still remains, the following operation may be performed. The surgeon grasps the prepuce with a pair of harelip forceps, leaving out as much of the outer fold as he wishes to remove, and cutting this away at one stroke of the knife. He then slits up the inner fold with a crooked bistoury passed in a director.

In paraphymosis the glans can generally be returned by pressing the blood out of it, after immersion in cold water, and drawing forwards the prepuce. Leeches may be applied to the glans to diminish its bulk. If these means do not succeed, the stricture must be cut through.

Amputation of the penis is necessary in cancer of that organ; but it should be done before the glands are affected. One stroke of the knife is sufficient for the purpose, after which the bleeding vessels must be secured.

Strictures in the urethra are contractions of the canal; which may be either temporary, when they are called spasmodic; or permanent, in which case there is a projecting ridge of the membrane, or a continued contraction occupying some length of the canal. The latter are also subject to attacks of spasm from inflammation, &c.; and vary in their state under different circumstances. If there be only a single stricture, it will be generally found at the bulb of the urethra; that is, about six and a half or seven inches from the mouth of the urethra; and where strictures are situated nearer to the end of the penis, there is almost always one in the former part. The symptoms of the complaint are diminished stream of urine, which is voided more frequently than is natural, and with difficulty; gleet, nocturnal emissions, impeded ejection of the seminal fluid in coition; irritability of the bladder, which secretes a mucous fluid. Sometimes there is a complete paroxysm of fever; and occasionally swelling of the testicle. Stranguary and total retention of urine are sometimes the consequence of a stricture, which becomes affected with spasm from some occasional cause.

Our first object in treating strictures is to ascertain the number and situation of the contractions. The bougie should be curved to the requisite degree (which is necessary in all cases where these instruments are introduced) and oiled before its introduction.

The surgeon holds the glans penis lightly with the fore finger and thumb of the left hand, just under the corona glandis, and introduces the bougie with the right hand, carrying it forwards gently, and drawing the penis upwards, so as to make the urethra tense. When he meets with an obstruction, he waits a little and tries again. He should make a mark with the nail on the bougie, opposite to the end of the urethra, if he cannot pass a stricture; and then try a smaller instrument. The same plan must be pursued, until all the contractions are ascertained. If he makes this examination with a soft white bougie, he may get an impression of the stricture by pressing gently, which will be of service in the subsequent treatment. For the cure of the complaint common bougies may be used; or they may be armed with caustic.

The common bougie acts mechanically by dilating the contracted portion. The largest instrument, that the urethra will admit, should be passed into the bladder daily, and left there for ten minutes at first, gradually lengthening the time. It should be secured by tying it to the end of the penis. The size of the bougie should be increased, as the strictures dilate.

Where caustic is used, a small piece of argentum nitratum is inserted in the end of a bougie, and surrounded laterally by its substance. This is termed an armed bougie. In using this method, we ascertain first how large a common bougie will pass to the stricture, and mark accurately the distance of the contraction; then take a caustic bougie of the same size, and mark the distance on this also. We then carry it pretty quickly down to the stricture, against which we hold it steadily, at first for a short time (less than a minute) but afterwards longer. This is to be repeated every other day, and to be practised successively with the different strictures that are met with. Mr. Whately has recommended a peculiar mode of employing caustic. He breaks a piece of kali purum, with a hammer, into bits, of which the largest should not exceed a pin's head, and keeps these in a phial with a ground stopper. He passes a bougie through the stricture, and marks the situation of the contraction. In the end of this he makes a small hole with a pin, inserts a bit of the kali smaller than a pin's head, and covers it with lard. He passes this bougie, properly curved, down to the stricture, and lets it rest for a few seconds, that the kali may dissolve; he then urges it about one-eighth of an inch forwards, allows it to rest, and then passes it on about as much further. He now withdraws it to the beginning of the stricture, and passes it through again once or twice. This is to be repeated every seven days, the size of the bougie being increased as much as the stricture will admit. Mr. Whately adopts this plan, from supposing that the membrane of the urethra is diseased for some extent.

A new passage is sometimes formed by the use of bougies. Here all instruments should be laid aside, if the circumstances admit, to give an opportunity for the parts to recover.

Fistula in perineo. When the urethra is very much obstructed, nature often endeavours to procure relief by ulceration on the inside of that part of the urethra, which is between the stricture and the bladder. Hence the urine insinuates itself into the cellular substance of the perineum, scrotum, &c. causing suppuration and mortification. If the patient survive, the sloughs are detached, leaving a free communication between the urethra and the external surface, and the openings thus produced, by which urine is evacuated, are called fistulæ in perineo. The treatment consists in removing the stricture, which is the cause of the complaint, and this must be attempted both by the caustic and common bougie. If the fistula does not heal, when the urethra is perfectly restored to its natural dimensions, it should be laid open like any other sinus, which does not seem disposed to heal. A catheter or staff having been passed into the bladder, a director is introduced along the sinus, until it meets the former instrument, then it will be easy to divide the sinuses with the crooked knife. An elastic catheter should be worn until the wound has healed, which should be dressed from the bottom. The treatment of the complaint, which terminates in a fistula in perineo will be considered under the next head.

Retention of urine. When the evacuation of urine is prevented by any particular cause, the bladder becomes remarkably distended. Its fundus ascends towards the navel, and forms a hard circumscribed swelling above the pubes, while the lower portion of the viscus bulges towards the rectum. Violent pain and straining, tension of the abdomen, cold sweats, anxiety, &c. are attendant symptoms. When the cause of the retention does not close the urethra, and it has proceeded to a consi-

siderable extent, the urine comes away by drops through the natural passage, leaving the bladder still distended. If the canal, through which the urine ought to flow be obstructed, inflammation and ulceration or sloughing ensue. When this happens in the urethra, fistulæ in perineo are the consequence. But the bladder itself may slough and burst. Retention of urine arises from the following causes. Weakness, or paralysis, of the bladder, inflammation of this viscus or of the adjacent parts, a spasmodic affection of the urethra, or some actual contraction of the passage.

The paralytic retention of urine may be caused by an injury to some part of the spinal marrow; by an overdistension of the bladder, arising from retaining the water too long after an inclination is felt to void it, &c. Two objects are to be accomplished in the treatment; to draw off the fluid distending the bladder, and to restore the natural contractile power of the viscus. The use of the catheter at certain stated periods accomplishes the first of these; the internal use of cantharides, blisters to the sacrum, pubes, or perineum, cold water thrown on the hypogastrium, cold bath, &c. promote the second indication. The catheter must be used regularly and frequently, until the cure is completed.

The retention arising from enlargement of the prostate belongs to this division. A neglect of the patient to obey the natural calls to void his urine is the first cause; and the regular use of the catheter is the most efficacious means of cure.

Use of the catheter. This instrument is either inflexible and made of silver, or flexible and elastic, which is composed of the elastic gum. There are also flexible catheters made of a fusible metal, and others composed of the bougie plaster; but the former are employed the most frequently. The elastic catheter is less irritating to the urethra than a silver tube, and it can be introduced in cases where a metallic inflexible instrument will not pass. The most favourable posture for the introduction of the catheter is that in which the patient lies down, with his pelvis at the edge of the bed, and the legs hanging to the ground. The corona glandis should be held between the thumb and fore-finger of the left hand, so as to avoid compressing the corona glandis. The catheter, well oiled, should be introduced, with the concavity towards the abdomen, until its point has nearly reached the bulb. The handle should now be brought slowly forwards, between the patient's thighs, and the point will consequently describe that portion of a circle which is necessary for its entering the bladder. In the latter stage of the operation, the penis, which before had been drawn upwards, should be allowed to sink down. If an impediment is met with in any direction, let the point be withdrawn a little, and then pushed gently onwards according to the course of the urethra; but force should be avoided by all means. The fore-finger of the left hand introduced into the rectum will sometimes facilitate the operation. When the prostate gland is enlarged, the urethra turns upwards very suddenly, just behind the pubes; hence the end of the catheter should be more bent upwards. It has also been found, that by withdrawing the stilet of an elastic gum catheter for a small distance, the instrument itself becomes more curved; and by this means the point of the instrument may be elevated in the urethra in the due direction. Many surgeons intoduce the catheter as far as the perineum, with its convexity towards the abdomen, then keeping the point stationary, they make the handle describe a semicircular movement upwards, so as to bring the concavity of the instrument towards the pubes; after which the operation is finished as in the former method.

When the retention of urine arises from an inflammatory cause, the nature of the disorder is entirely altered. Strictures in the urethra, when very bad, and irritated so as to fall into spasmodic contraction, are the most frequent source of this kind of retention. However, virulent gonorrhœa, bad piles, injuries of the perineum, fistula in ano, and the absorption of cantharides from blisters may have the same effect. The treatment of such cases must be of the antiphlogistic kind; venesection, leeches to the perineum, warm baths, fomentations to the perineum, and hypogastric region; opium by the mouth, and in clysters, are consequently to be employed. The use of the tinctura ferri muriati internally is also a very powerful assistant in such affections. The patient may take fifteen drops every ten minutes until it acts. A common clyster will often suffice in slight cases.

If none of these methods succeed, and the catheter or bougie cannot be introduced, it becomes necessary to puncture the bladder; which operation is neither dangerous nor painful, and fails in success probably, because it is employed generally

too late. It may be done from the perineum, pubes, or rectum. The two latter places are so much preferable to the former, that we shall describe those operations only. When the prostate gland is enlarged, (and such a case often requires the paracentesis vesicæ) the operation must be done above the pubes: if the patient should be fat, it would be preferable to puncture from the rectum. When all circumstances are equal, experience has not hitherto discovered any very decisive advantage in either of these methods over the other.

When the distension of the bladder can be clearly felt above the pubes, the surgeon may plunge a curved trochar directly into its cavity, about an inch above the bone, as in the paracentesis abdominis. He should remember to direct the point of the instrument in the axis of the bladder, and not to urge it forwards when the resistance to the point ceases. Then the stilet should be withdrawn, and the canula pushed onwards. The latter part must be confined in its situation, and should remain in the bladder until the natural passage is re-established: or, after a few days, an elastic catheter may be introduced through it, and the canula withdrawn. If the bladder cannot be felt so distinctly, the surgeon may dissect down to its surface before he penetrates it with the trochar.

In operating from the rectum a long curved trochar should be employed. The two first fingers of the left hand serve as a direction to the instrument, which is firmly held in the right, and should be passed through the very middle of the projection caused by the distended bladder, care being taken to accommodate its direction as much as possible to the axis of the bladder. After forty-eight hours the canula may be withdrawn, and the artificial opening will serve until the natural passage is restored.

In women the bladder should be tapped above the pubes, although it might be done from the vagina.

If the surgeon should not be called in until the urethra has ulcerated, and the urine become diffused, it will be his duty to make free incisions, particularly in the perineum, for the discharge of that fluid, and to use those general means which are likely to allay the constitutional irritation. He must then wait until the operations of nature have separated the sloughs caused by the urine, endeavouring however to introduce an elastic catheter, where he should allow it to remain. Poultices, fomentations, and the warm bath should be resorted to, if there are any appearances of inflammation, and abscesses, or accumulations of urine, should be opened early and freely.

Incontinence of urine. Sometimes this fluid dribbles away without any sensation of the patient. Here paralysis of the bladder is the cause, and may be induced in various ways, as from injuries of the spine, over-distension of the organ, &c. In the latter case, the urine should be carefully drawn off at regular intervals; cold bathing, bark, blistering the sacrum or perineum, electricity, tincture of cantharides internally, &c. will be of service.

Sometimes the patient can hold his urine to a certain degree, when an irresistible propensity to evacuate it comes on. Here irritability of the bladder is the cause, and may be induced by bad piles, fistula in ano, &c. Opium, the warm bath, fomentations, diluting drinks, &c. may be resorted to when no obvious cause appears.

Imperforate vagina. Sometimes the labia have their opposed surfaces grown together, leaving perhaps merely a small opening, through which the urine is imperfectly discharged, but marked with a line, showing the proper distinction. This may be congenital, or the effect of disease. Sometimes a thin membrane closes both the meatus urinarius and vagina in newly born children. In both these cases the use of the knife is necessary; and lint should be interposed between the divided surfaces. There is another form of the same mal-formation, in which the vagina alone is closed; and no symptoms appear until puberty, when the menstrual discharge does not flow. The uterus swells, and at last a kind of labour pains comes on. Here the membrane must be divided to discharge the accumulated menses, and the edges of the cut kept asunder.

Imperforate anus. The part may either be closed by a membrane, or be too contracted to allow the feces to be evacuated. It may be rightly formed at its outer part, but terminate in a cul de sac, or there may be no vestige whatever of anus. In the first species, a division of the membrane is the remedy; and in the second, a dilatation of the contracted part by the crooked bistoury. If an obstruction should be discovered within the gut, it may be perforated with the trochar, introduced according to the course of the intestine. The latter species is attended with very little hope of saving life. The surgeon may cut in the

situation of the anus, and follow his dissection along the sacrum in order to find the end of the gut, which, when found, should be punctured.

Fistula in ano. Any formation of matter near the anus is very likely to terminate in this complaint; the suppuration extends in the fat and cellular substance round the rectum, and sinuses form, having small external apertures, and seldom healing without an operation. The commencement of the disorder may be a phlegmonous abscess, attended with considerable sympathetic fever, or it may have a more erysipelatous character, spreading more widely, being more superficial, and attended with depression of the powers of the constitution. The former is seen in young, strong, and healthy subjects, the latter in weakened, intemperate, and unhealthy constitutions. The parts in the neighbourhood of the disease are often affected, and hence retention of urine, strangury, prolapsus and tenesmus, piles, &c. are produced. The complaint sometimes begins in an induration of the skin near the anus without pain. This hardness gradually softens and suppurates. The matter may either point in the buttock, at a distance from the anus, or near this latter part, or in the perineum. It may escape from one opening, or from several. Sometimes there is not only an external aperture, but another internal one, communicating with the cavity of the intestine.

A soft poultice and fomentations are the best means of treating these abscesses; which, if they are phlegmonous, should not be opened until the skin has become thin, but, when they are of the erysipelatous kind, should be punctured immediately to prevent any further extension of the malady. The general treatment must correspond with the nature of the constitutional disturbance. In all abscesses about the anus, the incision should comprehend all the skin covering the matter, as the cavity is then most likely to fill up from the bottom. The dressing should be small in quantity, light, and unirritating. If, however, the case passes into a fistula, it will be necessary to make it an open wound by cutting through the rectum from the end of the hollow to the anus. A probe having been introduced at the external opening of the fistula, serves as a director for the probe-pointed knife, which will be felt in the rectum by the surgeon's left fore finger. If the fistula should not have penetrated the gut, the bistoury should be pushed through its side. The probe may now be withdrawn, and the operation completed by bringing the knife out with its point applied to the finger which was in the intestine, and thus all between the edge of the knife and the anus must be divided. A soft piece of lint should now be placed in the wound, and remain until it is loosened by suppuration, and all the future dressings should be mild and unirritating. The callosities of which surgeons have complained so much in these cases, arise from injudicious treatment, and particularly from the use of caustic and stimulating applications.

Prolapsus ani. The internal coat of the gut may be protruded through the sphincter, or a portion of the intestine with all its coats may descend. Causes which weaken the sphincter, and such as force the intestine downwards, contribute to this affection. Costiveness, tenesmus kept up by hemorrhoids, ascarides, fistula in ano, stone, &c. are of this kind. The cause should be removed when that is practicable. The gut must be replaced, but previously clysters, fomentations and poultices, or leeches, and cold washes, are necessary. Horizontal posture, and avoiding costiveness, are very important points. A compress and bandage may be necessary to retain the replaced gut, and astringent clysters have been advised. If the protruded part has become indurated, thickened, and painful, and will not admit of reduction, it may be extirpated. Sometimes an introsusception, commencing at the cæcum, has protruded at the anus. This case is quite beyond the powers of art.

Prolapsus, inversio, and *retroversio uteri,* are considered under the article MIDWIFERY.

LITHOTOMY.

The existence of a stone in the bladder causes various symptoms in the bladder itself, and others in neighbouring parts. The former are frequent inclination to void the urine, which sometimes stops suddenly from the stone mechanically obstructing its passage, pain in making water, and particularly after the discharge, from the bladder contracting on the foreign body; mucus, and sometimes blood in the urine, and pain on exercise. The latter are an uneasiness and itching at the end of the penis, leading the person to draw and elongate the prepuce, sense of weight in the perineum, tenesmus, numbness of the thighs, &c.

These symptoms come on in fits. In order to ascertain the fact, a solid steel instrument, shaped like a catheter, and called a sound, is introduced into the bladder, where its point, meeting the stone, gives decided information to the surgeon. It must be moved in various directions after its introduction, as it may not immediately or easily come in contact with the stone. The operation should never be performed, unless the stone can be plainly felt before the operation: the rectum should be previously emptied, but it is more advantageous for the bladder to be full. The patient is to be placed with his pelvis at the edge of a table, and the staff introduced into the bladder. The thighs and legs are then bent so as to enable him to grasp the soles of the feet with his hands, and the limbs are retained in this position by broad garters, doubled and placed by means of a noose round the wrists, carried over the back of the hand, and inside of the foot; then brought up again, and continued round the wrist and ankle and firmly tied. The staff is shaped like a sound or catheter, and has a groove for conducting a cutting instrument into the bladder. An assistant standing on the patient's right side holds the handle of the staff with one hand, making its convexity project in the perineum, and draws aside the scrotum with the other. An incision should be made through the integuments, commencing on the left side of the raphe of the perineum just opposite to the membranous part of the urethra, and continued obliquely downwards and outwards for about three inches between the anus and ischium. The transversalis perinei should then be cut through, and the membranous part of the urethra freely opened, so as to expose the groove of the staff. The beak of the gorget is now introduced into the groove, and the operator takes the handle of the staff into his left hand, holding the gorget in his right. He then thrusts the gorget into the bladder, keeping its beak in close contact with the groove of the staff, and bringing the handle of the latter instrument downwards and forwards, in order to raise its point, and make its direction coincide with the axis of the bladder. The cutting edge of the gorget, by this mode of introduction, divides the prostate gland and neck of the bladder. This instrument is used of various figures by different surgeons. The best perhaps is that in which the cutting edge of the instrument extends horizontally from its beak, from which it may be carried to the length of three quarters of an inch. A good anatomist may perform the operation with a scalpel, which instrument will enable him to divide the parts with more exactness. The escape of the urine shows that the bladder is opened. The staff should now be withdrawn, and a proper pair of forceps passed along the concave surface of the gorget into the bladder, for the purpose of seizing and extracting the stone. This instrument is first employed as a probe to ascertain the position of the stone, which being accomplished, the blades are to be expanded and moved in such a direction as to grasp it, and the instrument very firmly held, may then be slowly withdrawn, being moved from side to side in order to bring the foreign body through the wound. If the stone be very large, it may be expedient to dilate the wound with a curved knife, or to break the stone in the bladder by means of forceps constructed for that purpose. In the latter case, and in instances where the stone is broken in the operation of extracting it, the bladder should be washed out with lukewarm water to remove any small fragments. Careful examination with the finger is necessary to ascertain that nothing is left behind. A compress of lint, pledget, and T bandage, may be put on, but they are of little service, as the urine escapes through the wound. Since peritoneal inflammation is the occurrence most to be feared after lithotomy, great attention to the state of the abdomen is required, and on the least indication of such a consequence, venesection, leeches, warm bath, warm fomentations, blisters, emollient clysters, and purgatives, should be resorted to, according to the symptoms.

This mode of performing lithotomy is called the lateral operation; it has been performed with an instrument called a lithotome caché, instead of the gorget. This is a long narrow knife, concealed in a grooved instrument, which is passed into the bladder along the groove of the staff exposed in the way already described. A spring being then compressed makes the knife rise out of the groove, and the instrument is withdrawn in this state, cutting the prostate and bladder as it recedes. In former times an opening has been made into the bladder above the pubes, particularly the young subjects; this was called the high operation, but has long been disused.

Spina bifida is a swelling situated on the spine of infants at the time of birth. It

consists of a sac, filled with an aqueous fluid, and composed of the integuments and the membranous sheath of the spinal marrow protruding through a fissure caused by a deficiency in the bones. The subjects are generally weak; diarrhœa, paralytic state of the lower limbs, and inability to retain the urine and feces often attend. The tumour enlarges, inflames and ulcerates, and then the patient dies; but this occurrence takes place at different periods. No treatment has hitherto been of any service.

Caries of the vertebræ. This is a disease of the spine, generally attended with a degree of curvature, and with a paralytic state of the lower limbs. It is most frequent in children, but not peculiar to them. The affection of the limbs is first observed. There is an unwillingness to move about, and the patient often trips and stumbles. The legs involuntarily cross each other. The power of directing the feet to any exact point is then lost, and the natural sensibility of the legs and thighs becomes much impaired. At this time there is usually a more or less marked bending of the spine forwards, occasioning an angular projection of the spinous processes. The general health becomes much affected, and the urine and feces are discharged involuntarily. The cause of all these complaints is the diseased state of the vertebræ, which are softened, and more or less absorbed, affecting the inclosed medulla spinalis. In the progress of the disorder the bodies of three or four vertebræ may be intirely destroyed so as to lay bare the front of the spinal marrow. We are indebted to Mr. Pott for proposing the only treatment that has ever afforded relief in this affection, *viz.* that of making an issue on each side of the diseased portion of the spine. This can be best accomplished with the calx cum kali puro. Several pieces of sticking plaister are to be stuck together, and a hole should then be cut in the mass corresponding to the size of the intended issue. This is applied on the back, and a thin layer of the caustic placed in the hole, and covered by another piece of plaister. In four or five hours the plaister should be removed, and a poultice applied until the eschar separates. The issue is then filled with peas or beans, confined by adhesive plaister, over which pressure should be made by firmly binding on a piece of sheet lead. The issues must be kept open until the complaints have intirely disappeared.

AMPUTATION.

In whatever part this is performed, the surgeon's object is the same, *viz.* to save enough of the surrounding soft parts to cover the extremity of the bone, and enough of skin to cover the whole. The stump is always treated as a wound which should be united by the first intention; its sides are therefore brought together, and retained in apposition by straps of adhesive plaister, and appropriate bandages. By this, which is the improved method of modern surgery, introduced by Mr. Alanson of Liverpool, the wound made by removing a thigh is often agglutinated in forty-eight hours, and the patient consequently escapes the dreadful pain and irritation, and vehement sympathetic affection of the constitution, which almost invariably attended the old practice of dressing the stump with dry lint as an open wound, and consequently healing by means of granulation and cicatrization, instead of adhesion.

In *amputation of the thigh*, surgeons used to cut at once down to the bone, and saw that through; but in order to save more soft parts, and thereby to avoid the projection of the bone, which commonly attended that method, the double incision was devised; by which the skin and muscles are divided separately. More difficulty is experienced here than in any other amputation, in saving muscles enough to cover the bone, which, in this particular instance, is especially desirable, from the pressure which the end of the stump must experience in supporting the weight of the body. The sound leg should be tied to the table, and the tourniquet applied on the inside of the thigh. The limb should be cut off as near to the knee as possible. A circular incision should then be made by the surgeon, standing on the outside of the limb, through the skin and adipous substance. The integuments should be drawn upwards by an assistant, and any cellular connection that prevents their retraction should be divided. A cut should now be carried through the loose muscles, at the part to which the skin has been withdrawn, and when they have retracted, those which are fixed to the bone should be divided at the point to which the former had retracted. The latter may be separated from the surface of the bone, for a short distance, by a common scalpel, to allow of the bone being sawed higher up than it could be otherwise. This part of the operation should follow, the surface of the wound being kept out

of the way of the saw, by means of a retractor, which is a piece of linen somewhat broader than the stump, torn at one end, in its middle part to the extent of about eight or ten inches. It is applied by placing the exposed part of the bone in the slit, and drawing the ends of the linen upward on each side of the stump. Besides defending the surface of the wound from the teeth of the saw, the retractor will undoubtedly enable the operator to saw the bone higher up than he otherwise could do. The femoral artery should be drawn out by means of a pair of forceps, and tied separately, other large arteries should also be secured, without including any of the surrounding soft parts. Smaller branches must be taken up with the tenaculum. It is necessary to slacken the tourniquet, in order to discover the vessels. The wound should then be thoroughly cleansed from all coagulated blood, by means of a soft sponge and water, and one end of each ligature removed. The skin and muscles are now to be placed over the bone, in such a direction that the wound shall appear only as a line across the face of the stump, with the angles at each side, from which the ligatures should be brought out. The skin is supported by long strips of adhesive plaster, applied at right angles to the line of union of the wound, the ligatures are guarded by lint spread with spermaceti cerate; and a linen roller is carried round from above downwards, two cross pieces having first been put over the end of the stump. The dressings should not be moved for four days.

In *amputating the leg*, the bones should be sawn through, about four inches below the patela. The tourniquet is applied in the lower part of the thigh. After cutting through the skin, which should be drawn upwards, it must be reflected from the flat surface of the tibia, and front of the leg, so as to cover those parts which could not be covered by any large muscle. The calf is then to be cut through, by an oblique incision slanting upwards, the rest of the muscles, and the interosseous ligament, should be divided by a double-edged knife, called a catlin, and the bones sawn, after the previous application of a double-tailed retractor.

In *amputating the arm*, or *fore-arm*, we should preserve as great a length of the limb as the case will allow.

Amputation of the shoulder-joint has been done in various ways. An incision should be carried through the skin and deltoid muscle, down to the bone from the front of the joint, a little below the clavicle, obliquely downwards and outwards. The deltoid should then be turned up so as to expose the head of the bone, which must be brought entirely into view, by dividing the orbicular ligament all round. One cut of an amputating knife will then separate the limb. The axillary artery should be immediately tied. This vessel must be firmly compressed, by an assistant, above the clavicles, during the whole of the operation.

The *fingers* and *toes* should be removed at their joints. Make a circular incision through the skin, about one third of an inch below the articulation, draw the integuments up, and cut through one lateral ligament of the joint, which you can then dislocate. The remaining connections are easily divided. Bring the skin together over the end of the bone. If you amputate at the first joint, make two cuts, one at the back, and the other towards the front; these must meet when the bone is removed. It is sometimes necessary to tie the arteries.

Paronychia, or *whitlow*, is an abscess occurring about the nails, or still more deeply under the soft parts of the fingers. In the latter case, swelling of the arm, inflammation of the lymphatics, and considerable constitutional disturbance frequently attend. The complaint is always very painful, attended with great throbbing, and often terminating in the loss of the nail. We should, if possible, prevent suppuration, by the employment of local antiphlogistic means. If these do not succeed, a soft poultice may be used, and the collection should be opened as soon as possible.

Venesection. When a vein is to be opened in any part of the body, pressure must be made on the vessel, between the place where the puncture is to be made, and the heart. This prevents the return of blood through the vessel, makes it swell, and become conspicuous. As the supply of blood is still continued through the arteries, the vein bleeds freely when it is opened; but care must be taken, particularly in the arm, not to apply the ligature so tightly as to stop the pulse. The bandage should be placed a little above the elbow, and the most prominent and conspicuous vein may be opened; excepting that, if equally convenient, one would avoid the vessel lying over the brachial artery. The vein may be fixed by placing the thumb of the left hand

a little below the place where it is designed to introduce the lancet. That instrument should be pushed obliquely into the vein, and when its point is a little within the cavity, the opening may be rendered sufficiently large, by carrying the front edge forward and upward, so as to bring it out of the part. In many cases, where we wish to make a sudden impression on the vascular system, we make the opening longer than usual, that the blood may be withdrawn more suddenly, and cause fainting. The stream may be accelerated by putting the muscles of the fore-arm into action. It stops when the ligature is removed, or at least, if the surgeon press with his left thumb below the vein. The sides of the incision should be placed in contact, and maintained in that condition by a small compress of linen, bound on with the bleeding fillet applied in the form of the figure of eight. In opening the external jugular vein, the pressure must be made with the surgeon's finger; and the compress should be fastened by means of sticking plaister. The temporal artery may be opened by a simple puncture; and the bleeding may always be stopped by a compress fastened by means of sticking plaister. The operation of bleeding may be followed by various unpleasant consequences; as ecchymosis round the vein, inflammation of the integuments, absorbents, fascia, or vein itself. The former symptom generally disappears of itself in a week or ten days; the others may be treated according to the general principles of surgical practice.

PARTICULAR FRACTURES.

We shall say a few words on the most common and important kinds of fracture.

Fracture of the lower jaw may be detected by introducing a finger into the mouth, and pressing on the front portion of the bone, while the fingers of the other hand are applied on the outside to the back of the bone. Alternate pressure in these situations occasions a very distinguishable crepitus. When the broken ends are adapted to each other, some wetted pasteboard is to be applied along the outer surface and base of the bone; and over this a bandage, with four tails, should be placed. The centre of this bandage is applied to the chin: the two posterior tails tied together at the top of the head, and the other two more posteriorly. The wet pasteboard adapts itself to the figure of the part, and constitutes, when dry, a splint exactly accommodated to the form of the jaw. All motion of the broken bone should be avoided; hence talking, chewing, &c. are improper; hence, too, the food should be soft, and introduced by a spoon.

The *fracture of the clavicle* is attended with a displacement of the bone; its scapular portion being drawn downwards and forwards. In order to restore it, let the shoulder be drawn backwards, and the arm raised; then the surgeon should place the fracture in as even a position as he can, cover it with a piece of soap plaister, and keep the shoulder back by means of the figure of eight bandage: the fore-arm and elbow being well supported by a string. A leather apparatus lacing behind, and having straps to pass in front of the shoulders, similar to the instruments used for girls with the view of keeping the shoulders back, is a more effectual mode of accomplishing the object.

It is often difficult to detect *fracture of the ribs*. By placing the fingers where pain is felt, or where the blow was received, a crepitus can be distinguished in many cases, on making the patient cough; yet if the matter be doubtful, the safest plan is to treat the patient as if his ribs were broken. It will be readily seen how emphysema, extravasation of blood, &c. may occur when the bone is displaced inwardly. Our object is to keep the broken ends motionless. Hence, after a piece of soap plaister has been applied externally on the situation of the fracture, a broad roller should be put firmly round the chest; or we may apply an apparatus made expressly for the purpose, consisting of a broad girth, with three or four buckles and straps, which may be tightened at pleasure. Bleeding is proper, unless particular circumstances contraindicate it.

In *fractures of the os brachii*, after restoring the limb to its natural figure, and putting on a piece of soap plaister, apply a splint, lined with a pad of soft materials, from the acromion to the external condyle, and another from the margin of the axilla to the internal condyle. Some add two others, one before and one behind. They must all be carefully fastened with tapes, and the fore-arm and hand should be well supported by a sling. There is always a distinguishable crepitus in fractures of the fore-arm. After a piece of soap-plaister has been applied, two splints must be employed: one is to be placed along the inside, and the other along the outside of the

fore-arm. The limb is to be in the mid state, between pronation and supination; and the inner splint should reach far enough into the hand to support it, and prevent it from falling into the prone state.

In *fractures of the olecranon* the elbow must be placed straight, to approximate as much as possible the broken ends, and the limb must be continued in that position until the patient has recovered.

When the *os femoris* is broken, there is severe local pain, an incapacity to move the limb, a distinguishable crepitus on motion, and deformity of the part from retraction of the lower portion. The latter appearance will occur more readily, in proportion as the fracture is more oblique; and it arises entirely from the action of the muscles which are fixed in the bone below the fracture, together with the flexors of the knee. Besides the shortening of the limb, produced by the retraction of the lower portion of the fractured bone, there is another deformity arising from its being rotated outwards; an effect produced by most of the large muscles of the thigh. The higher the fracture, the more difficult is it to prevent displacement. When the neck of the thigh bone is broken, there is severe pain in the groin, much aggravated by motion of the part. The extremity is shortened, the limb turned out, and the trochanter higher than usual towards the pelvis. Yet the limb may be drawn down to its natural length, in doing which a crepitus is sometimes perceived. In order to relax as much as possible the muscles which tend to displace the broken bone, a bent position of the thigh and leg was recommended by Mr. Pott. He recommended that the patient should lie on the side of the fracture, with the thigh bent on the pelvis, and the knee half bent. A broad splint well padded should be placed under the thigh, from above the trochanter to below the knee, and another should extend from the groin below the knee on the opposite surface. Narrower splints should occupy the intervals between those on the inside and outside of the thigh. The splints should be fastened as firmly as they can be borne, by means of leathern straps. A patient with a broken os femoris should by no means be placed on a soft bed, as the trunk of the body depresses it into a hollow, and by sliding downwards increases the displacement.

Fracture of the patella is generally caused by violent exertion of the muscles, whose tendons are inserted into this bone, and not by direct violence. The upper end of the bone is drawn upwards by the muscles, and a total inability to extend the leg is generally observed. The muscles should be relaxed, by extending the knee, and bending the thigh on the pelvis: they may also be surrounded with a roller, a compress being placed just above the upper portion of the broken bone. The newly-formed substance which unites the broken ends is of a ligamentous or cartilaginous nature, and not bony.

Fractures of the leg. If they affect both bones, there can be no doubt of the nature of the case; but the symptoms are more uncertain, when the fibula alone is broken. The limb should be laid on its outside, with the knee moderately bent. Japanned iron, or wooden splints shaped to the part, and covered with soft pads, are employed. The leg having been placed in the above-mentioned position, extension is made, if necessary; and the under splint, covered with its pad, and having an eighteen-tailed bandage laid on it, is passed under the limb. Having observed that the ends of the bones are in exact contact, the surgeon places his soap plaister over the fractured portion, and lays down the bandage. Another soft pad is then put over the upper surface of the leg, and the other splint applied. The leather straps attached to the splints are fastened with sufficient tightness, to prevent any motion of the fractured part. When the pressure of the splints is painful, soft pads are necessary.

Ruptured tendo Achillis. The large tendon of the muscles of the calf of the leg is sometimes torn asunder by the violent exertion of those muscles. An inability to extend the ankle, and a consequent impaired power of progression follows. The ends of the tendon may be approximated by straightening the ankle and bending the knee. The foot may be kept in this position by the assistance of bandages. The case requires about the same degree of confinement as a fracture. Some persons have not kept their bed for this accident, but have walked about with a high-heeled shoe. The tendon of the plantaris muscle is sometimes ruptured, and the accident is attended with the symptoms as if the tendo Achillis were torn.

PARTICULAR DISLOCATIONS.

Lower jaw. This bone can only be luxated forwards, when the condyloid pro-

cesses advance beyond the eminentiæ articulares. In this case the mouth remains open, and cannot be shut, there is pain; impaired and almost destroyed articulation and deglutition, &c. One or both condyles may be displaced To reduce it, the thumbs well covered should be introduced as far backward as possible along the grinding teeth. The surgeon then elevates the front of the bone with his fingers, and the palms of his hands, while he depresses the condyles with his thumbs, and the latter prominences are thus forced back into the glenoid cavities of the temporal bones.

Dislocations of the head and vertebræ are probably imaginary occurrences, as we know hitherto of no well attested example of their occurrence.

The *os humeri* is probably luxated more frequently than any other bone. It may be displaced downwards, forwards, and backwards. In all these cases a vacancy is distinguishable under the acromion, in consequence of the absence of the head of the humerus from the glenoid cavity of the scapula. The head of the bone forms a preternatural tumour in some situation. The elbow cannot be carried close to the chest, nor can the limb be elevated, without extreme pain, to a line with the acromion. Great pain is caused by the pressure of the head of the bone in its unnatural position, particularly when it lies in the axilla. Our object is to dislodge the head of the os brachii from its unnatural situation, in order to bring it on a level with the glenoid cavity of the scapula. To accomplish this purpose, extension must be made, that is, the limb must be drawn forcibly outwards, and the bone itself should be made to operate as a lever, which can be best effected by the surgeon's knee placed under it towards the head, while he depresses the elbow at the proper time, so as to raise the head towards the glenoid cavity. The patient's body should be fixed by placing a broad towel round the chest, and tying it to some immoveable point. The extension should be gradual, and kept up unremittingly, which can be best effected by means of pullies. The elbow should be bent, and the extending power applied just above the condyles of the humerus. When the surgeon finds that the head of the bone is drawn out of its unnatural position, he may allow the extension to be remitted, and depress the elbow. The arm should afterwards be kept quietly in a sling, a piece of soap plaster, and a spica bandage being applied to the shoulder.

Elbow. Dislocations at this joint are very difficult to discover, from the swelling which comes on so quickly. The radius may be displaced forwards, and here the flexion of the elbow is almost entirely destroyed. The ulna may at the same time be driven backwards: it may also be pushed inwards, so as to occupy the place of the radius. All these are easily reduced, when they are ascertained. Leeches and cold washes should be employed afterwards.

Wrist. The distortion consequent on a displacement of the carpus is so considerable, that the nature of the case is rendered immediately obvious. The reduction is easy, and after it has been accomplished, the hand and fore-arm should be bound on a splint, and supported by a sling.

Thigh. The os femoris may be displaced downwards and inwards, so that the head rests on the obturator foramen; upwards and outwards, when the head is towards the sacro-ischiatic foramen, and the trochanter forwards; and upwards and forwards, so that the head rests upon the os pubis. In the first case the toes are turned out, and the limb elongated. In the second, the limb is shortened, the foot turned inwards, and the buttock more prominent. Great pain is excited by attempting to move the limb in all cases of luxation, and a vacuity is discernible in the natural situation of the head of the bone. The patient should be placed on the side opposite to the accident, and his pelvis should be fixed by means of a sheet passed under the perineum Extension may be made by fixing a broad towel, or the pullies, just above the condyles. When the head of the bone is on the dorsum ilii, the extension is to be continued until it has been brought to the acetabulum, into which the surgeon must guide it. In the dislocation on the obturator foramen, we should make a lever of the bone by passing a towel under the thigh, near the trochanter, and elevating it after a slight extension has been made, the condyles being at the same time depressed.

The *patella* may be dislocated either inwards or outwards. Its reduction is very easy when the muscles inserted into it have been relaxed.

The *knee* hardly admits of complete luxation without such injury of the parts as would render the loss of the limb necessary. The nature of the accident must be obvious from the altered figure of the parts, and replacement is perfectly easy. Inflammation must be guarded against afterwards.

The *ankle* may be dislocated outwards, the fibulæ being at the same time broken. This is generally a compound luxation; the extremity of the tibia, when displaced from the astragulus, very often penetrating the integuments. Formerly this accident was considered as a cause of amputation; and many practitioners have been in the habit of sawing off the projecting portion. Yet by replacing the bone, closing the wound, keeping the parts quiet, &c. the injury has been often recovered. Luxation may also occur in the opposite direction, and forwards. The latter is very difficult to retain in place, as the muscles of the calf are so apt to move the foot.

SURIANA, in botany, so named in honour of Joseph Donat Surian, a genus of the Decandria Pentagynia class and order. Natural order of Succulentæ. Rosaceæ, Jussieu. Essential character: calyx five-leaved; petals five; styles inserted into the inner side of the germs; seeds five, naked. There is but one species, *viz.* S. maritima, a native of the sea coast of South America, and the islands of the West Indies.

SURRENDER, in law, a deed or instrument, testifying that the particular tenant of lands or tenements for life, or years, doth sufficiently consent and agree, that he which has the next or immediate remainder or reversion thereof, shall also have the present estate of the same in possession; and that he yields and gives up the same unto him; for every surrenderer ought forthwith to give possession of the things surrendered. Where a surrender is made in consequence of a fresh lease, and that lease turns out invalid, the surrender is considered as not valid, and the former lease is established. Surrender into the hands of the lord is the mode of passing copyholds, and a surrender to the use of a will is necessary, in order to pass them by a will.

SURROGATE, one who is substituted or appointed in the room of another; as the bishop or chancellor's surrogate.

SURSOLID, in arithmetic and algebra, the fifth power, or fourth multiplication of any number or quantity, considered as a root. See ROOT.

SURSOLID *problem*, in mathematics, is that which cannot be resolved but by curves of a higher nature than a conic section, *v. gr.* in order to describe a regular endecagon, or figure of eleven sides in a circle, it is required to describe an isosceles triangle on a right line given, whose angles, at the base, shall be quintuple to that at the vertex; which may easily be done by the intersection of a quadratrix, or any other curve of the second kind.

SURVEYING. This important art, however difficult its attainment may appear, is nevertheless to be comprised within a very few general rules. The accuracy of the work must depend entirely on the correctness of the instruments employed, the steadiness of the hand and eye of the operator, and the faithfully tracing the given lines and angles on the paper designed to exhibit the estate, or premises, under examination. The following leading principles will give an insight into the mode of displaying the results, whatever may be the means employed for their computation. First: We are to reject the actual curvature of our globe, in all land surveys, that is, where no current of water, or the level of any fluid, is under consideration: such curvature amounts to about eight inches in every mile, either of latitude or of longitude. In brief, we consider the earth to be flat, instead of spherical. Secondly. We must ever carry in mind, that every triangle is equal to half a parallelogram of equal base and altitude; as shown under the head of GEOMETRY. Thirdly. That wherever there is a deviation from the horizontal, there will be a greater extent of surface displayed on a scite than if the same were horizontal. To illustrate this, let an orange be cut through in the middle, and the flat part, *i.e.* the section, be placed on a level table: it is evident that the round surface of the half orange will offer more surface than the flat section which lays upon the table; but, if it were required to build on the semi-spherical surface, it would be found that no more houses, &c. could be raised thereon, than would stand on the extent of the flat section. The reason of which is, that no more perpendiculars can be raised on one than on the other. This shows how fallacious is the mode of purchasing what is called side-long, or hanging land, by the acre. The greater the deviation from the horizontal, the more is the base diminished. Fourthly, The surveyor must recollect that all planes, of whatever extent or form, may be divided into, and be represented by, triangles of various forms and dimensions, whose aggregate will amount to the measurement of the area thus partitioned off: for, as Euclid justly observes, "All the parts, taken together, are equal to the whole." It will be further seen, that every figure may

either directly, or circuitously, be commuted into a triangle, of corresponding area: but it may be necessary, at the same time, to observe, that the squaring of the circle has not hitherto been perfected; though we have arrived so nearly to the completion of that object as to leave no room for regret at the want of absolute precision.

These points being completely understood, the learner may proceed to the rudiments of surveying; supposing him to be grounded in the few preliminary problems which enable him to describe the ordinary figures: should he not have obtained any previous information on that subject, we recommend that he turn back to the heads of GEOMETRY and MATHEMATICAL *instruments;* under which he will find various items indispensable towards his progress.

We shall submit a few propositions which the student may work with his compasses, plain scale, and protractor: when able to do all that may be needful on paper, he may then try his hand with one or other of the various instruments in use among surveyors.

Proposition I. "To ascertain the contents of the square field A B C D, fig. 1. Plate XV. Miscel." Here little is to be done; one of the sides being measured, say 70 yards, and multiplied by itself, will give 4,900 square yards for the area; or one acre (i. e. 4,800 square yards) and 100 square yards.

Proposition II. "To survey the field A B C D, fig. 2." This figure having the sides A B and C D parallel, and at right angles to A D, add the lengths of those parallels, say 70 and 90 yards, together; divide half their sum (i.e. 80) and multiply that half by the depth of A D, say 70; which being multiplied by the medium length, G F, gives an area of 5,600 square yards. The parallelogram, A B E D, might have been computed by simply multiplying its length by its breadth; and the triangle, B C E, might be taken separately, thus: the depth, (or altitude) B E, 70 yards, to be multiplied by half C E, (*i.e.* 10 yards) this would give 700; and the produce of A B, which is 70, by B E which is also 70, would be 4,900; making in all 5,600, as above shown.

Proposition III. "To survey the inclined parallelogram A B C D, fig. 3." It is to be observed that, in all inclined figures, the altitude is ascertained by a perpendicular from the base, as at C, to the parallel of that base, as at E on the line A B. Now, the triangle B E C being equal to the triangle D F A, and likewise similar thereto, it is evident that by transposing the former from the right to the left of the figure, it would make it rectangular; as shown by the dotted line: therefore multiply the base D C, say 100 yards, by the altitude C E, say 80 yards, and the area will be found to contain 8,000 square yards.

Proposition IV. "To survey the irregulars, fig. 4." Here A C and B D are parallel, butn either C D nor A B are perpendicular thereto, nor parallel between themselves. We must, therefore, cut off the triangles A E B and C F D; whose areas will be found by multiplying half their respective breadths, by their whole depths; or their whole breadths, by half their depths: the centre part, E C B F, is treated as a parallelogram, already described. The whole of the calculations being added together give the area of the entire figure A C B D.

Proposition V. "To ascertain the area of the trapezium, A B C D." This figure is no where parallel, and has all its sides of unequal lengths. The easiest mode of surveying it, is by drawing a diagonal between the two most distant points, C and B; and making off-sets, rectangular to that diagonal, from E to A, and from F to D. These off-sets give the altitudes; E A being the altitude of the triangle C A B, say 40 yards; and F D being the altitude of the triangle B D C, which we will take at 80 yards. Now the diagonal, C B, becomes a base common to both triangles; therefore add the two altitudes together; namely, 40 to 80, which make 120; take their half = 60, and multiply by the base, which we will call 140: the area will contain 8,400 square yards. It will be seen that this proposition is, in a great measure, the foundation of all horizontal computation; and the student should remark that all figures, having many sides, may be divided into trapezia, and those again into triangles: each figure will have two sides more than the numbers of triangles it contains: thus, fig. 5, has four sides, and contains two triangles; fig. 6, has five sides, and contains three triangles.

Proposition VI. "To survey the pentagon, or five-sided field, A B C D E, fig. 6." Divide it into the three triangles, A B C, D A C, E A D, and having found their respective altitudes, as already shown, by perpendiculars drawn to their summits from their respective bases, multiply half those altitudes by those bases, and the three products will amount to the whole area of the pentagon.

Proposition VII. "To ascertain the area of the irregular six-sided figure, or hexagon, (fig. 7) A B C D E F." In this, some of the angles point inward. First draw the line C E, which will divide the figure into two trapezia; *viz.* C E B A and C E F D, next divide each of these trapezia by the diagonals B E and CD, into two triangles respectively: the areas of the four triangles, B A E, B C E, F C D, and C E D, will, when added together, exhibit the contents of the whole figure.

Proposition VIII. "To measure the irregular field A B C D E, fig. 8." The figure here given has two curved sides, one of which projects, the other which inflects: the ordinary parts, which can be divided into triangles, are worked in the manner already shown; but the curved parts must be measured in the following mode: Draw the line E D, and from it make three, or more, off-sets to the curved part; take from E to 1, as a base, and half the depth of the off-set 1, as an altitude; multiply them together: then take from 1 to 2, as a base, and the mean of the depths of the off-sets 2 and 3, for the altitude; multiply these also together: do the same for the space between 2 and 3, and calculate the end, between 3 and D, as was done from E to 1; the sum of their several products, added together, will show the area of the curve. As the other curve bends inward, draw the line A E, and treat it the same as was done regarding E D: then, considering the entire triangle, A E D, as a part of the field, compute its contents, and deduct from it the measures taken by means of the off-sets 4, 5, 6: the residue, added to the contents of the curve from E to D, and of the triangles A B C, and A C D, will show the area of the whole figure A B C D E. It is obvious that, in this manner, the extent of water may be deducted from the area of any field.

The next figure, No. 10, shows the method of surveying with a plain-table, which usually stands upon three legs, and has a compass attached to one side. There is a box-wood frame that fits on the board of the plain-table, and is graduated with 360 degrees. This serves to show the direction of any line from the centre of the board, where there is a brass stud, or plate, let in; and it also compresses the paper so as to prevent its shifting. To this instrument there is a brass rule of two feet long, with ends turned up at right angles, in which are slits, or sights, to direct the surveyor's eye. He places the rule so as to touch the brass centre, and directing it to any particular point, observes the angle it makes, according to the index on the box-wood frame, while an assistant measures the distance, from the centre under the plain-table, to the point observed. The surveyor draws a line on the paper, in the direction of the brass rule, from the exact centre of the plain-table, and notes down at the side of that line, what its length may be in chains, links, &c. according to Gunter's scale; or else in yards and feet, as in familiar measurement. Thus, in fig. 10, A represents the plain table, placed in the centre of the field B C D E: *f g* is the rule with sights: the figures written on the sides of the lines proceeding to the four corners, express their several distances from the centre of the plain-table. This mode of surveying is peculiarly suited to small surveys; especially to the interiors of enclosed places; and has the advantage of forming the plan on the paper, as the survey proceeds: for the number of yards, &c. being set off, from the scale on the brass rule, on the several directing lines, as from the centre A to B, C, D, and E, respectively; and their lengths being determined by their several due measures, the lines B C, C D, D E, E B, will give a true fac-simile of the shape of the field. The contents must be ascertained by dividing the field, as before explained, into triangles, whose conjoint measurements will amount to its contents.

Although the plain-table is not a sufficient instrument for general purposes, it is in the foregoing instance extremely convenient: its use may be extended, under due precaution, to ascertaining the distances of remote, or of inaccessible, objects, situated on the same level with itself. But for such purposes a theodolite, standard triangle, circumferentor, or some instrument capable of taking heights, as well as levels, is ordinarily employed. The following proposition will illustrate the above point.

Proposition XI. "To ascertain the distance of an object at C, from the point B, fig. 11." Draw the base line, B A, in any convenient direction, and from each station (commonly marked by surveyors ⊙) observe what angle is made; *viz.* at B, ascertain the value (or extent) of the angle CBA, and at A, the value of the angle C A B; take care to be very correct as to the measurement of your base line; which we will take at 120 yards. Now, the points A and B being established at a certain dis-

tance, and the two angles they mutually form with C being ascertained by the graduated edge of the instrument; it follows that the intersection of the two sights, from B to C, and from A to C, will determine the exact locality of C. let the line B C be measured on the same scale from which B A was taken, and it will show the distance of C from B. In this manner the whole horizon may be surveyed from the base line A B, except such parts as may lay in, that is, occupy the same direction therewith. And it is to be observed, that in laying a base line, the nearer the angle of intersection, as at C, is to a right angle, the more exactly will the distance be denoted. Hence a great extent of base line is to be preferred, when at command; and, if practicable, no angle under twenty degrees should be made: it is always better to take a new station than to make acute angles with the object to be surveyed, which may, for the most part, be easily avoided in horizontal sights, but in vertical observations, very acute angles will ordinarily occur.

Thus, in *Proposition X*, "which relates to ascertaining the heights of P and O, (fig. 12) from the level of C, and the distance of C from B, cannot be effected but by acute angles." Here, in lieu of laying the base line, A B, as nearly as possible square with the point C, we place it in the exact direction therewith. Then, after taking the angles of elevation from the horizon at the station B, to the two points O and P, and measuring the exact length of the base line A B, the instrument is removed from B to A, where two more sights are taken to O and P. We have thus the two angles, P B A and P A B, determining the locality of P; and the two angles, O B A and O A B, determining the locality of O. Now the line, B A, being prolonged, and the perpendicular, P O, being likewise continued, will intersect in C. The lines, P B, O B, and C B, being measured on the same scale whence the base line, A B, was taken, the altitudes of P and of O, with their intermediate distance, will be given; while the distance of C from B will be exhibited.

We shall conclude this article with a few words on the manner of carrying a line of sight over a hill, as is often done for the formation of a road, or for the conducting a canal over a rising ground; in which case the level must be preserved.

Proposition XI. "To carry a line of sight, or a level, in the direction of A B, over the rising ground C." Ascertain where the line of sight strikes the hill at *e*; carry the instrument to that point, and, in the exact direction of the former sight, take a second sight from *e* to *a*, or to any convenient spot, where a pole and target should be fixed. See LEVELS. As this survey for a canal is to be taken by means of a spirit level, the exact altitude of each sight must be taken, by noting the height of the target from the plain, A B, at every sight, or by following up a regular succession of levels, each of which will be the height of the instrument above the last. Thus the hill will be ascended: the descent on the other side is effected by the inversion of the foregoing mode; always taking the descending levels of the target for canals, but for roads, or for laying down a meridional line, when once the summit is gained, a long sight may be taken to a distant object: this subject is pleasingly exemplified in a new work published by Longman and Co. entitled "Mathematics simplified, and practically illustrated," in which a great variety of instructive and useful matter will be found, together with the description of a new instrument, on a very simple construction, said to be equal to every branch of surveying.

SUS, the *hog*, in natural history, a genus of Mammalia, of the order of Belluæ. Generic character: four front teeth in the upper jaw, converging; six in the lower, projecting, two tusks in the upper jaw, short; two in the lower standing out, snout truncate, prominent, and moveable: feet cloven. These animals are allied by their teeth to the carnivorous quadrupeds, and by their cloven feet to the ruminating ones. They feed almost indifferently upon animal and vegetable substances, devouring with avidity what is most nauseous and disgusting. They use their snout for digging up the ground in quest of roots, are fond of rolling and wallowing in mud, and are distinguished by extreme fecundity. There are six species, of which the following are the most important:

S. scrofa, the common hog. All the varieties of this animal originate in the wild boar, which is found in most of the temperate regions of Europe and Asia. It is smaller than the domesticated animal, and uniformly of a dark grey colour, approaching to black. It is armed with formidable tusks, sometimes ten inches, or even more, in length, those in the under jaw curving inwards, and capable from their size, strength, and sharpness, of inflicting the most dread-

ful wounds. Before these animals attain their third year they are gregarious, and, when danger is at hand particularly, they muster in numerous parties, and with great promptitude, at the signal of alarm. Uniting thus, they present so formidable an array, as speedily to disperse the enemy, few creatures, or none, daring to commence an attack against such a combination of strength and valour as they exhibit. When the wild boar is complete in growth, he depends upon his solitary exertions for his protection, is seldom seen in society, ranging the forests alone; rarely commencing an attack, as his food consists almost solely of roots and vegetables, but repelling one with all the fierceness of courage, and all the resentment of retaliation.

These animals are often hunted by dogs, particularly of the mastiff breed. After many pauses in their progress, in which they turn round, and defy their enemies to the attack, which, however, is generally declined, they at length refuse to proceed, and halt for the grand and final conflict; in which, though eventually overpowered by the number of dogs, and the spears of the hunters, they defend themselves with the most astonishing intrepidity, perseverance, and energy, and, regarding their case as absolutely desperate, determine, at least, not to die unrevenged. See Mammalia, Plate XXI. fig. 1.

The common hog has smaller tusks and larger ears than the wild boar, and is generally of a dull, or dirty, yellowish-white. It is clumsy in its shape, filthy in its manners, and gross and ravenous in its food, devouring almost every variety of rejected animal or vegetable substance, and distinguished by the quantity nearly as much as by the rankness of its food. The offal of the kitchen, garden, and barn, furnishes it with an exquisite banquet. It was rejected as unclean both by the founders of the Jewish and Mahometan religion, as unfit for human sustenance, for which it is, nevertheless, most admirably adapted, and of incalculable value. The sailors of the British navy are in a great degree supported by the flesh of that animal which Moses and Mahomet decided to be unfit for the food of man, and in most countries of Europe, it is an important and indispensible article of the food of the inhabitants. The hog is possessed of an acute smell, and is highly agitated during the violent blowing of certain winds, uttering the most dreadful screams, and exhibiting the highest restlessness, apprehension, and turbulence. It is fattened to an extraordinary size, and has been known to attain the almost incredible weight of 1215 pounds. It produces two litters in the year, and in each from ten to twenty young ones. The male must be kept at a distance from these, as it will otherwise destroy and devour them, and the female herself has often acted this unnatural part, and is particularly apt to do it, if observed attentively, during the crisis of parturition. The hog was unknown in America when that quarter of the world was discovered by the Spaniards, but now abounds in every part of it. The Chinese breed is most valued in England. There is an accidental variety of the domestic hog with undivided hoofs.

S. Ethiopicus, or the Ethiopian hog, is very similar to the last. It is fierce and formidable in the highest degree, and burrows in the ground, in deep recesses which it prepares with both its hoofs and nose. It is particularly distinguished by a large lobe, or wattle, beneath each eye.

S. baby-roussa is remarkable for the form and situation of the upper tusks, which are placed externally, and turn upwards in a curve towards the forehead. It abounds in the Indian islands, lives solely on vegetables, and rests itself, in sleep, by hooking its upper tusks round the branch of a tree. It can swim with rapidity, and is valued for food.

S. sajassu, or the Mexican hog, or pecari, is the only animal of the genus native of America, where it is gregarious, fierce and dangerous, and is occasionally seen in herds of several hundreds. It feeds on fruits and roots, and also on serpents, lizards, and toads, and will attack and devour the rattle-snake, we are told, without the slightest injury. It is less than the common hog, has bristles nearly resembling the prickles of an hedge-hog, and is also distinguished by an orifice on its back, from which perpetually issues a most fetid watery humour. The pecari will skin snakes by means of its teeth and feet, before it devours them, with great dexterity. The common hog is reported, on good authority, to attack and eat the rattle-snake with the same impunity as the pecari. For the baby roussa, see Mammalia, Plate XX. fig. 2.

SUSPENSION, or *Points of Suspension*, in mechanics, are those points in the axis or beam of a balance, wherein the weights are applied, or from which they are suspended.

Suspension *of arms*, in war, a short truce agreed on by both armies, in order to bury the dead, wait for fresh instructions, or the like.

Suspension, in rhetoric, is the carrying on a period or discourse, in such a manner as to keep the reader in expectation of something considerable in the conclusion. But great care must be taken that the reader's expectation be not disappointed; for nothing is more contemptible than to promise much and perform little; or to usher in an errant trifle with the formality of preface and solemn preparation.

SWABBER, an inferior officer on board ships of war, whose employment it is to see that the decks are kept neat and clean.

SWARTZIA, in botany, so named in honour of Olof Swartz, M. D., a genus of the Polyadelphia Polyandria class and order. Essential character: calyx four-leaved; petals single, lateral, flat; legume one-celled, bivalve; seeds arillated. There are six species.

SWEDENBORGIANS, a modern religious sect, so called from their founder, Emanuel Swedenborg, a Swedish nobleman, who was born at Stockholm in the year 1689, and died at London, 1772; at the advanced age of eighty-four years. His father was a Lutheran bishop, and was president of the Swedish churches. During the early part of his life, Emanuel Swedenborg devoted himself, with uncommon assiduity, to the study of useful and honourable science, and his labours and acquirements soon procured him the notice of Charles XII. King of Sweden, who made him extraordinary assessor to the Royal College of the Mines, &c. a place of great honour, trust, and emolument.

In the year 1734, he printed at Leipsic his "Regnum Minerale," in three volumes, folio. He also wrote a treatise on the Position and Course of the Planets, and another on the Tides. Had the ingenious baron confined his attention to these useful and honourable pursuits, his learning and virtues would have secured to his memory the universal esteem and respect he would so justly have merited; but leaving the pursuits of learning for the mysteries of a new theological creed, he entirely devoted himself to metaphysical speculations and spiritual inquiries. Believing himself to have received an extraordinary manifestation of supernatural light, he forsook the paths of learning and rational science, and became the friend and associate of angels, and disembodied "ministers of grace." "I am," says he, in a letter to a friend, "a fellow, by invitation, of the Royal Academy of Sciences at Stockholm, but have never denied to be of any other community, as I belong to the society of angels, in which things spiritual and heavenly are the only subjects of discourse and entertainment; whereas, in our literary societies, the attention is wholly taken up with things of this world."

Thus abstracted from sublunary intercourse, and thus highly privileged to "see things invisible," the pious baron devoted a long life, and employed his extraordinary talents and genius in forming and establishing the following curious and ingenious system of Christian theology, which constitutes the subject of the present article.

1. Contrary to Unitarians, who deny, and to Trinitarians who hold, a trinity of persons in the godhead, the Swedenborgians maintain that there is a divine trinity in the person of Jesus Christ, consisting of Father, Son, and Holy Ghost, just like the human trinity in every individual man, of soul, body, and operation; and as the latter trinity constitutes one man, so the former constitutes one Jehovah God, who is at once the Creator, Redeemer, and Regenerator.

2. That Jehovah God himself came down from heaven, and assumed human nature for the purpose of removing hell from man, of restoring the heavens to order, and preparing the way for a new church upon earth; and that herein consists the true nature of redemption, which was effected solely by the omnipotence of the Lord's divine humanity.

3. They hold the notion of pardon obtained by a vicarious sacrifice or atonement, as a fundamental and fatal error; but that repentance is the foundation of the church in man; that it consists in a man's abstaining from all evils, because they are sins against God, &c.; that it is productive of regeneration, which is not an instantaneous, but a gradual work, effected by the Lord alone, through charity and faith, during man's co-operation.

4. That man has free-will in spiritual things, whereby he may join himself by reciprocation with the Lord.

5. That the imputation of the merits and righteousness of Christ is a thing as absurd and impossible, as it would be to impute to any man the works of creation: for the merits and righteousness of Christ consist

in redemption, which is as much the work of a divine and omnipotent being, as creation itself. They maintain, however, that the imputation, which really takes place, is an imputation of good and evil; and that this is according to a man's life.

6. That the doctrine of predestination and justification by faith alone, is a mere human invention, and not to be found in the word of God.

7. That the two sacraments of baptism and the holy supper are essential institutions in the New Church, the genuine and rational uses of which are now discovered, together with the spiritual sense of the holy word.

8. That the sacred scripture contains a threefold sense, namely, celestial, spiritual, and natural, which are united by correspondences; and that in each sense it is divine truth, accommodated, respectively to the angels of the three heavens, and also to men on earth.

9. That the books of the word, (or the scriptures), are those which have the internal sense, and are the five books of Moses, the books of Joshua, Judges, Samuel, Kings, the Psalms, and all the Prophets: also, the four Evangelists, and the Revelation; and that the other books, viz. the books of Ruth, the Chronicles, Ezra, Nehemiah, Esther, Job, Proverbs, Ecclesiastes, Song of Solomon, in the Old Testament; and the Acts, together with all the Epistles in the New, not having the internal sense, are not the word, or divine revelation.

10. That in the spiritual world there is a sun distinct from that of the natural world, the essence of which is pure love from Jehovah God, who is in the midst thereof; that the heat also proceeding from that sun, is, in its essence, love; and the light thence proceeding is, in its essence, wisdom; and by the instrumentality of that sun, all things were created, and continue to subsist, both in the spiritual and in the natural world.

11. They maintain, that there is not in the universal heaven, a single angel that was created so at the first, nor a single devil in all hell that had been created an angel of light, and was afterwards cast out of heaven; but that all both in heaven and hell are of the human race; in heaven such as had lived in the world in heavenly love and faith, and in hell such as lived in hellish love and faith.

12. That the material body never rises again; but that man, immediately after his departure from this life, rises again as to his spiritual or substantial body, (which was inclosed in his material body, and formed from his predominant love, whether it be good or evil), wherein he continues to live as a man, in a perfect human form, in all respects as before, save only the gross material body, which he puts off by death, and which is of no further use.

13. That the state and condition of man after death is according to his past life in this world; and the predominant love, which he takes with him into the spiritual world, continues with him for ever, and can never be changed to all eternity; but if evil, he abides in hell to all eternity.

14. That true conjugal love, which can only subsist between one husband and one wife, is a primary characteristic of the new church, being grounded in the marriage of goodness and truth, and corresponding with the marriage of the Lord and his church; and therefore it is more celestial, spiritual, holy, pure, and clean, than any other love in angels or men.

15. That the science of correspondences, (which has been lost for some thousands of years, but is now revived in the Theological Works of the Honourable Emanuel Swedenborg), is the only key, to the spiritual, or internal sense of the holy word, every page of which is written by correspondences, that is, by such things in the natural world as correspond with and signify things in the spiritual world.

16. That all those passages in the scriptures generally supposed to signify the destruction of the world by fire, &c. commonly called the last judgment, must be understood according to the above science, which teaches, that by the end of the world is not meant the destruction of it, but the destruction or end of the present Christian church, both among Roman Catholics and Protestants of every description, and that this last judgment took place in the spiritual world in the year 1757.

17. That the second advent of the Lord, which is a coming, not in person, but in the spiritual or internal sense of his holy word, has already commenced; that it is effected by means of his servant Emanuel Swedenborg, before whom he hath manifested himself in person, and whom he hath filled with his spirit, to teach the doctrines of the new church by the word from him; and that this is what is meant in the Revelation by the new heaven and new earth, and the new Jerusalem thence descending.

These doctrines, to say the least of them, are ingenious. Many persons indeed, of great respectability, and not a few men of learning and talent, even of the present day, believe that these doctrines are something more than ingenious. It is, however, not a little extraordinary, that, although the Swedenborgians openly deny the commonly received doctrine of a trinity of persons in the Godhead, and believe, as they certainly do, that to assert that doctrine is nothing less than tritheism, and when it is also considered that the system of the highly-illuminated baron has excluded that other orthodox doctrine of a vicarious sacrifice by the death of Christ, we say, under these considerations, it is not a little to be wondered at, that there should be found any persons still in communion with our established church, who profess themselves members of the New Jerusalem church, as revealed by Emanuel Swedenborg. But the wonder increases much, upon the consideration that some, even of the regular clergy of the English Church, are to be found among the disciples of the honourable baron! The present venerable and respectable minister of St. John's, Manchester, the Reverend Mr. Clowes, is not only an open professor of the faith of the New Church, but is also the well-known translator of all the baron's theological publications! The forbearing temper of many of our present ecclesiastical governors, and the liberal spirit of the times, are circumstances not a little honourable to the national character in general, and to our national clergy in particular. May this spirit and this forbearance continue to increase, until no discrepancy of mere opinion whatever, while unaccompanied by errors of conduct or depravity of heart, shall be made the foundation of hatred, or the pretext for exclusive civil and religious privileges!

SWERTIA, in botany, so named in honour of Eman. Sweert, a genus of the Pentandria Digynia class and order. Natural order of Rotaceæ. Gentianæ, Jussieu. Essential character: corolla wheel-shaped; nectariferous pores at the base of the segments of the corolla; capsule one-celled, two valved. There are six species.

SWIETENIA, in botany, *mahogany tree*, so named, in honour of the illustrious Gerard, L. B. à Swieten, archiater to Maria Teresa, Empress of Germany, a genus of the Decandria Monogynia class and order. Natural order of Trihilatæ. Meliæ, Jussieu. Essential character: calyx five-cleft; petals five; nectary cylindric, bearing the anthers at the mouth; capsules five-celled, woody, opening at the base; seeds imbricate, winged. There are three species. The S. mahogani, mahogany tree, is very lofty and spreading, with a wide handsome head; leaves reclining, alternate, shining, eight inches long, numerous on the younger branches; leaflets mostly in four pairs, quite entire, acuminate, bent in backwards, petioled, opposite, an inch and half long; racemes subcorymbed, with about eight flowers in each, axillary, solitary, two inches long, flowers small, whitish. The mahogany tree is a native of the warmest parts of America, and grows plentifully in the islands of Cuba, Jamaica, and Hispaniola; in these islands the tree grows to a very large size, so as to cut into planks of six feet breadth: those on the Bahama Islands are not so large; these, however, are frequently four feet in diameter, and rising to a great height, notwithstanding they are generally found on the solid rock, where there seems to be scarcely any earth for their nourishment. The wood brought from the Bahama Islands has usually passed under the name of Madeira wood; this the Spaniards make great use of for building ships; it is better adapted to this purpose than most sorts of wood yet known, being very durable, resisting gun shots, and burying the shot without splintering. The excellency of this wood for all domestic purposes has been long known in England.

SWIMMING, the art, or act, of sustaining the body in water, and of moving therein; in which action the air-bladder and fins of fishes bear a considerable part. Some have supposed, that the motion of fish in the water, depends principally upon the pectoral fins, but the contrary is easily proved by experiment; for if the pectoral fins of a fish are cut off, and it be again put into the water, it will be found to move forward or sideways, upward or downward, as well as it did when it had them on. If a fish be carefully observed, while swimming in a bason of clear water, it will be found not to keep these pectoral fins constantly expanded, but only to open them at such times as it would stop or change its course; this seeming to be their principal, if not their only, use. The pectoral and ventral fins, in the common fishes of a compressed form, serve in the same manner in keeping the fish still, and serve in scarce any other motion than that towards the bottom: so that this motion of the fish, which has been

generally attributed to their fins, is almost wholly owing to their muscles, and the equipoise of their air-bladder. That the use of the pectoral and ventral fins is to keep the fish steady and upright in the water, is evident from the consequences of their loss: if they are cut off, and the fish put again into the water, it cannot continue in its natural erect posture, but staggers about and rolls from side to side. The fins of the back and anus are also of great use to the keeping the creature in its natural position, as is easily seen by cutting them off, and observing the motions of the fish afterwards. Though a great deal depends on the motion of the muscles of the several parts of the body, in the swimming of the fish, yet the tail, and those muscles which move the lower part of the body, to which it is affixed, are the great instruments by which their swift motions in the water are performed. The moving the tail, and that part of the body to which it adheres, backward and forward, or sideways any one way, throws the whole body of the fish strongly the contrary way, and even in swimming strait forward, the motion and direction are both greatly assisted by the vibrations of this part, as may be experienced in the motion of a boat, which, when impelled forward, may be firmly guided by means of an oar held out at its stern, and moved in the water as occasion directs. The dorsal muscles, and those of the lower part of the body between the anus and tail, are the principal that are used in the motion of this part, and these are therefore the most useful to the fish in swimming. The muscles of the belly seem to have their principal use in the contracting the belly and the air-bladder. They have been supposed of use to move the belly-fins; but there are too many of them for such a purpose, and these fins have each its peculiar muscle fully sufficient to the business. The use of the tail in swimming is easily seen, by cutting it off, and committing the fish to the water without it, in which case it is a most helpless creature.

Brutes swim naturally, but men attain this art by practice and industry: it consists principally in striking alternately with the hands and feet which, like oars, row a person forward: he must keep his body a little oblique, that he may the more easily erect his head, and keep his mouth above water.

We shall here insert some maxims on the art of swimming that may be useful, and which are said to have been written by the late Dr. Franklin.

1. That though the legs, arms, and head, of a human body, being solid parts, are specifically something heavier than fresh water, yet the trunk, particularly the upper part, from its hollowness, is so much lighter than water, as that the whole of the body, taken together, is too light to sink wholly under water, but some part will remain above, until the lungs become filled with water; which happens from drawing water into them instead of air, when a person, in the fright, attempts breathing while the mouth and nostrils are under water. 2. That the legs and arms are specifically lighter than salt water, and will be supported by it, so that a human body would not sink in salt water, though the lungs were filled as above, but from the greater specific gravity of the head. 3. That therefore a person throwing himself on his back in salt water, and extending his arms, may easily lie so as to keep his mouth and nostrils free for breathing, and, by a small motion of his hands, may prevent turning, if he should perceive any tendency to it. 4. That in fresh water, if a man throws himself on his back, near the surface, he cannot long continue in that situation, but by proper action of his hands, on the water. If he uses no such action, the legs and lower part of the body will gradually sink till he comes into an upright position, in which he will continue suspended, the hollow of the breast keeping the head uppermost. 5. But if in this erect position, the head is kept upright above the shoulders, as when we stand on the ground, the immersion will, by the weight of that part of the head that is out of water, reach above the mouth and nostrils, perhaps a little above the eyes, so that a man cannot long remain suspended in water with his head in that position. 6. The body continuing suspended as before, and upright, if the head be leaned quite back, so that the face looks upwards, all the back part of the head being then under water, and its weight consequently in a great measure supported by it, the face will remain above water quite free for breathing, will rise an inch higher every inspiration, and sink as much every expiration but never so low as that the water may come over the mouth. 7. If therefore a person, unacquainted with swimming, and falling accidentally into the water, could have presence of mind sufficient to avoid struggling

and plunging, and to let the body take this natural position, he might continue long safe from drowning, till perhaps help would come. For as to the clothes, their additional weight while immersed is very inconsiderable, the water supporting it; though when he comes out of the water, he would find them very heavy indeed. The subject has within the last two or three years been investigated in Nicholson's Philosophical Journal, whence it should seem that if a person could have sufficient presence of mind never to raise his hands above water, he could not sink.

SWIVEL, in gunnery, a small piece of artillery carrying a shot of half a pound weight, and fixed in a socket on the top of a ship's side, stern, or bow, and also in the tops; the trunnions of this piece are contained in a sort of iron crotch, the lower end of which terminates in a cylindrical pivot, resting in the socket so as to support the weight of the cannon. By means of this swivel, which gives name to the piece of artillery, and an iron handle, the gun may be directed by hand to any object.

SWORD, an offensive weapon worn at the side, and serving either to cut or stab. Its parts are the handle, guard, and blade; to which may be added the bow, scabbard, pummel, &c. Fencing-masters, however, divide the sword into the upper, middle, and lower part; or the fort, middle, and foible.

SYENA, in botany, a genus of the Triandria Monogynia class and order. Essential character: calyx three-leaved; petals three; anthers oblong; capsule one-celled, three-valved. There is only one species, viz. S. fluviatilis; this is a minute mossy plant; stem somewhat branched, decumbent; leaves capillaceous, in whorls; flowers axillary, white, peduncled, solitary. It is a native of Guiana, in rivulets.

SYLLABLE, in grammar, a part of a word, consisting of one or more letters, pronounced together.

According as words contain one, two, three, four, &c. syllables, they are denominated monosyllables, bissyllables, trissyllables, tetrasyllables, polysyllables, &c. and the division of a word, into its constituent syllables, is called spelling.

SYLLABUS, in matters of literature, denotes a table of contents, or an index of the chief heads of a book or discourse.

SYLLOGISM, in logic, an argument or term of reasoning, consisting of three propositions; the two first of which are called premises, and the last the conclusion. Syllogisms are nothing but the expressions of our reasonings, reduced to form and method: and hence, as every act of reasoning implies three several judgments, so every syllogism must include three distinct propositions. Thus, in the following syllogism:

Every creature possessed of reason and liberty is accountable for his actions.
Man is a creature possessed of reason and liberty:
Therefore man is accountable for his actions.

We may observe that there are three several propositions, expressing the three judgments implied in the act of reasoning: the two first propositions answer the two previous judgments in reasoning, and are hence called premises: as being placed before the other, which is termed the conclusion. We are also to remember, that the terms expressing the two ideas whose relation we inquire after, as here, "man" and "accountableness," are in general called the extremes; and that the intermediate idea, by means of which the agreement or disagreement of the two extremes is traced, viz. "a creature possessed of reason and liberty," takes the name of the middle term. Hence, by the premises of a syllogism, we are always to understand the two propositions where the middle term is severally compared to the two extremes; for these constitute the previous judgments, whence the truth we are in quest of is by reasoning deduced. The conclusion is that other proposition, in which the extremes themselves are joined or separated, agreeably to what appears upon the above comparison. As, therefore, the conclusion is made up of the extreme terms of the syllogism; so that extreme, which serves as the predicate of the conclusion, goes by the name of the major term; and the other term, or subject of the conclusion, is called the minor term. From this distinction of the extremes arises also a distinction between the premises; that proposition, which compares the greater extreme with the middle term, being called the major proposition; and the other, where the lesser extreme is compared with the middle term, being called the minor proposition. In a single act of reasoning, the premises of the syllogism must be self-evident truths, other-

wise the conclusion could not follow. For instance, in the major of the above-mentioned syllogism, *viz.* "every creature possessed of reason and liberty is accountable for his actions," if the connection between the subject and predicate could not be perceived by a bare attention to the ideas themselves, the proposition would require a proof itself; in which case, a new middle term must be sought for, and a new syllogism formed to prove the said major: and should it so happen, that in this second essay there was still some proposition whose truth did not appear at first sight, recourse must be had to a third syllogism to prove it. And when, by conducting our thoughts in this manner, we at last arrive at some syllogism, where the premises or previous propositions are intuitive, or self-evident, truths, the mind then rests in full security, as perceiving that the several conclusions it has passed through stand upon the immoveable foundation of self-evidence, and when traced to their source terminate in it. The great art lies, in so adjusting our syllogisms to one another, that the propositions severally made use of as premises may be manifest consequences of what goes before, so as to form one connected demonstration.

With respect to the different forms or figures of syllogisms, it frequently happens that the middle term is the subject of the major term, and the predicate of the minor: but though this disposition of the middle term be the most natural and obvious, it is not, however, necessary; since the middle term is often the subject of both the premises, or the predicate in both; and sometimes it is the predicate in the major, and the subject in the minor proposition. Now this variety in the order and disposition of the middle term, constitutes what logicians call the forms or figures of syllogism.

But besides this distinction of syllogisms into different figures, there is also a further subdivision of them in every figure, called modes, or moods. See Mood.

These distinctions of syllogism, according to figure and mood, respect chiefly simple syllogisms, or those limited to three propositions, all simple; and where the extremes and middle term are connected immediately together. But as the mind is not tied down to any one form of reasoning, but sometimes makes use of more, sometimes of fewer premises, and often takes in compound and conditional propositions, there hence arises other distinctions of syllogisms.

When in any syllogism the major is a conditional proposition, the syllogism itself is termed conditional. Such is the following one:

If there is a God, he ought to be worshipped;
But there is a God:
Therefore he ought to be worshipped.

In syllogisms of this kind, the relation between the antecedent, or the conditional part "if there is a God," and the consequent "he ought to be worshipped," must ever be real and true; that is the antecedent must always contain some certain and genuine condition, which necessarily implies the consequent; otherwise the proposition itself will be false, and therefore ought not to be admitted into our reasonings. There are two kinds of conditional syllogisms, one of which is called in the schools *modus ponens*; because from the admission of the antecedent they argue to the admission of the consequent, as in the syllogism above: the other is called *modus tollens*, because in it both antecedent and consequent are rejected, as in the following syllogism:

If God were not a being of infinite goodness, neither would he consult the happiness of his creatures;
But God does consult the happiness of his creatures;
Therefore he is a being of infinite goodness.

Again, as from the major's being a conditional proposition, we obtain conditional syllogisms; so where it is a disjunctive proposition, the syllogism is also called disjunctive, as in the following example.

The world is either self-existent, or the work of some finite, or some infinite being.
But it is not self-existent, nor the work of a finite being:
Therefore it is the work of an infinite being.

Now a disjunctive proposition is that, where of several predicates, we affirm one necessarily to belong to the subject, to the exclusion of all the rest, but leave that particular one undetermined: hence it follows, that as soon as we determine the particular predicate, all the rest are to be of course rejected; or if we reject all the predicates but one, that one necessarily takes place. When, therefore, in a disjunctive syllogism, the several predicates are enumerated in the major; if the minor establishes any one of these predicates, the conclusion

ought to remove all the rest; or if in the minor, all the predicates but one are removed, the conclusion must necessarily establish that one.

In the several kinds of syllogisms hitherto mentioned, we may observe, that the parts are complete; that is, the three propositions of which they consist, are expressed in form. But it often happens, that some one of these premises is not only an evident truth, but also familiar and in the mouths of all men; in which case it is usually omitted, whereby we have an imperfect syllogism, that seems to be made up of only two propositions: such is the following one:

Every man is mortal;
Therefore every king is mortal.

Here the minor proposition, "every king is man," is omitted, as being so clear and evident, that the reader may easily supply it.

SYLVAN, in mineralogy, a genus which is divided into four species; viz. 1. "The native sylvan," of which the colour is intermediate between tin white and silver white: it occurs massive and disseminated, and also in various kinds of crystals: internally it is shining, and its lustre is metallic: its specific gravity is from 4.1 to 6.1. Its constituent parts are

Sylvan	92.55
Iron	7.20
Gold	0.25
	100

Before the blow-pipe it melts as easily as lead, emits a thick white smoke, and burns with a light green colour, and a sharp disagreeable odour. When exposed to a low heat, it is converted into an oxide: by an increase of temperature, it melts into a brownish black glass, in which gold grains are interspersed: at a still higher heat, the oxide is completely volatilized. It occurs in veins, and is accompanied with iron pyrites, blende, lead-glance, quartz, and lithomarge, and is found in Transylvania. It bears a strong resemblance to antimony, and was formerly called "aurum problematicum," — "white gold ore," &c. It was denominated "sylvan" by Kirwan, and is so called by Jameson, who thinks it more expressive than "tellurium," a name proposed by Klaproth.

2. "Graphic ore," which is likewise found in Transylvania: it is worked as an ore of gold, and has obtained the name of graphic gold. It consists of

Sylvan	60
Gold	30
Silver	10
	100

It occurs, in veins, in clay porphyry, accompanied with iron pyrites, grey copper ore, blende, and sometimes, though rarely, with native gold. Before the blow-pipe it burns with a green flame, and is volatilized.

3. "Yellow sylvan ore," which is white, inclining to yellow, and is found disseminated and crystallized. Specific gravity 10.6. It dissolves in nitrous acid, and during the solution nitrous gas is evolved: the constituent parts are

Sylvan	44.75
Gold	26.75
Lead	19.5
Silver	8.5
Sulphur	0.5
	100.

This is found in Transylvania, and is worked on account of the proportions of the silver and gold.

4. "Black sylvan ore," which is of an iron black colour, and occurs massive, and in small, thin, and longish six-sided tables: externally it is splendent, with a metallic lustre: and within it is shining: specific gravity is almost 9. Its constituent parts are

Sylvan	18.8
Lead	24.8
Gold	4.15
Silver	0.25
Copper	0.6
Sulphur	1.4
Oxide of manganese	9.2
Quartz	43.7
	100.

It is found in Transylvania: it melts before the blow-pipe: the sulphur and sylvan are soon volatilized, and a blackish brown globule remains, which being melted with borax, a sort of silvery gold grain appears. It dissolves with effervescence in acids, and the nitro-muriatic acid extracts the gold from it.

SYMPHONIA, in botany, a genus of the Monodelphia Pentandria class and order. Essential character: one styled; corolla globular; berry five-celled. There is only

one species: *viz.* S. globulifera, a native of Surinam.

SYMPHYTUM, in botany, *comfrey*, a genus of the Pentandria Monogynia class and order. Natural order of Asperifoliæ. Borragineæ, Jussieu. Essential character: corolla tubular, ventricose; throat closed by lanceolate rays. There are three species. We shall notice the S. officinale, common comfrey: this plant has a perennial fleshy root, externally black; stem two or three feet high, upright, leafy, winged, branched at the top, clothed with short bristly hairs, which point downward; leaves waved, pointed, veiny, rough; the radical leaves on foot-stalks, broader than the rest; clusters of flowers, in pairs, on a common foot-stalk, with an odd flower between them; corolla yellowish white, sometimes purple; the rays downy at each edge. It is a native of Europe and Siberia; it is frequent in watery places, on the banks of rivers and ditches; flowering from the end of May to September.

SYMPLOCOS, in botany, a genus of the Polyadelphia Polyandria class and order. Natural order of Guaiacanæ, Jussieu. Essential character: calyx five-cleft; corolla five-petalled, erect at the base; stamens in four rows, growing to the tube of the corolla; fruit five-celled. There are four species.

SYNDIC, in government and commerce, an officer in divers countries entrusted with the affairs of a city, or other community, who calls meetings, makes representations and solicitations to the ministry, magistracy, &c. according to the exigency of the case. The syndic is appointed to answer and account for the conduct of the body, he makes and receives proposals for the advantage thereof, controuls and corrects the failings of particular persons of the body, or at least procures their correction at a public meeting. In effect, the syndic is at the same time both the agent and censor of the community.

SYNECDOCHE, in rhetoric, a kind of figure or rather trope, frequent among orators and poets. There are three kinds of synecdoches; by the first, a part is taken for the whole, as the point for the sword, the roof for the house, the sails for the ship, &c. By the second, the whole is used for a part. By the third, the matter whereof the thing is made is used for the thing itself; as steel for sword, silver for money, &c. To which may be added another kind, when the species is used for the genus, or the genus for the species.

SYNGENESIA, in botany, the name of the nineteenth class in Linnæus's system, consisting of plants in which the anthers, or male organs of generation, are united into a cylinder, the filaments on which they are supported being separate and distinct: this class contains the numerous tribe of compound flowers. The orders of this class arise from the different modes of intercommunication of the florets, or lesser partial flowers contained within the common calyx. This intercommunication admits of the four following cases. 1. When the florets are all hermaphrodite. 2. When they are hermaphrodites and females. 3. When there are hermaphrodites and florets of no sex: and, 4. When they are males and females.

SYNGNATHUS, the *pipe-fish*, a genus of fishes of the order Cartilaginei. Generic character: snout nearly cylindrical; mouth terminal, without teeth or tongue, and furnished with a lid; body lengthened, jointed, and mailed with many-sided scales; no ventral fins. These fishes frequent the coasts of the sea, and subsist upon worms and insects, and the ova of fishes. There are eight species of which we shall notice the following.

S. acus, or the great pipe-fish, sometimes attains the length even of three feet, but is generally only fourteen inches long, extremely slender, and tapering towards the extremity. Its ova are found lying in spring in a longitudinal channel at the bottom of the abdomen, and the young are produced from this groove completely formed. It is found in the seas of Europe.

The S. hippocampus, or sea-horse pipe-fish, inhabits the shores of the European and Indian seas, and is about ten inches long. When the head is bent downwards, it has a very considerable resemblance to that of a horse.

S. foliatus, or the foliated pipe-fish, is the most singular species of the genus, and this singularity consists chiefly in its possessing appendages, situated on very strong and rough spines, on the back, tail, and abdomen, of the shape of leaves, and which might easily be supposed by a cursory observer the real leaves of some of the fuci tribe. In the one presented to Sir Joseph Banks, and engraved in Shaw's Zoology, there are fourteen of these curious processes. This animal presents one of the most extraordinary objects exhibited by nature in the immense variety of her living productions. See Pisces, Plate VI. fig. 3.

SYNOD, in astronomy, a conjunction, or concourse of two or more stars, or planets, in the same optical place of the heavens.

SYNODENDRON, in natural history, a genus of insects of the order Coleoptera: antennæ clavate; the club lamellate; thorax gibbous, muricate or unequal; tip filiform, horny, palpigerous at the tip. There are four species.

SYNODICAL, something belonging to a synod; thus synodical epistles are circular letters written by the synods to the absent prelates and churches, or even those general ones directed to all the faithful, to inform them of what had passed in the synod. For the synodical month, see the article MONTH.

SYNOVIA, the name given to a liquid secreted within the capsular ligaments of the joints, to facilitate motion by lubricating these parts. The synovia of the ox is a viscid, semi-transparent fluid, of a greenish white colour, which soon acquires the consistence of jelly, and not long after becomes again fluid, depositing a filamentous matter. Synovia mixes with water, and renders it viscid. When this mixture is boiled it becomes milky, and some pellicles are deposited on the sides of the vessel. Alcohol produces a precipitate when added to synovia. This precipitate is albumen. After this matter is separated, the liquid still remains viscid; but if acetic acid be added, the viscidity disappears, and it becomes transparent, depositing a white filamentous substance, which resembles vegetable gluten. It is soluble in cold water, and in concentrated acids and pure alkalies. This fibrous matter is precipitated by acids and alcohol in flakes. The concentrated mineral acids produce a flaky precipitate, which is soon re-dissolved; but the viscidity of the liquid is not destroyed till they are so much diluted with water, that the acid taste is only perceptible. When synovia is exposed to dry air, it evaporates, and cubic crystals remain in the residuum, with a white saline efflorescence. The first are muriate of soda, and the latter carbonate of soda. This substance soon becomes putrid, giving out ammonia during its decomposition. By distillation in a retort, it yields water, which soon becomes putrid; water containing a portion of ammonia, and an empyreumatic oil, with carbonate of ammonia: by washing the residuum, muriate and carbonate of soda may be obtained. A small portion of phosphate of lime is found in the coaly matter. The constituent parts of synovia are the following:

Fibrous matter	11.8
Albumen	4.5
Muriate of soda	1.7
Soda	0.7
Phosphate of lime	0.7
Water	80.6
	100.0

SYNTAX, in grammar, the proper construction, or due disposition of the words of a language, into sentences, or phrases; or the manner of constructing one word with another, with regard to the different terminations thereof, prescribed by the rules of grammar. Hence the office of syntax is to consider the natural suitableness of words with respect to one another, in order to make them agree in gender, number, person, mood, &c. To offend in any of these points, is called, to offend against syntax; and such kind of offence, when gross, is called a solecism, and when more slight, a barbarism. Syntax is generally divided into two parts, *viz.* concord, wherein the words are to agree in gender, number, case, and person; and regimen, or government, wherein one word governs another, and occasions some variations therein.

SYNTHESIS, the putting of several things together, as making a compound medicine of several simple ingredients, &c.

SYNTHESIS, in logic, denotes a branch of method opposite to analysis, called the synthetic method.

SYRINGA, in botany, *lilac*, a genus of the Diandria Monogynia class and order. Natural order of Sepiariæ. Jasmineæ, Jussieu. Essential character: corolla four-cleft; capsule two-celled. There are four species, with several varieties. The S. vulgaris, common lilac, is a shrub growing to the height of eighteen or twenty feet, dividing into many branches; those of the white sort grow more erect than the blue; and the purple, or Scotch lilac, has its branches yet more diffused. The lilac is very common in the English gardens, where it has been long cultivated as a flowering shrub. It is supposed to grow naturally in some parts of Persia; but is so hardy as to resist the greatest cold of this country.

SYRINGE, an instrument serving to imbibe, or suck in a quantity of any fluid, and to squirt or expel the same with violence.

SYRUP. See PHARMACY.

SYSTEM, in general, denotes an assem-

blage or chain of principles and conclusions, or the whole of any doctrine, the several parts whereof are bound together, and follow or depend on each other; in which sense we say, a system of philosophy, a system of divinity, &c.

SYSTEM, in astronomy, denotes an hypothesis or supposition of an arrangement of the several parts of the universe, whereby astronomers explain all the phenomena or appearances of the heavenly bodies, their motions, changes, &c. This is more properly called the systems of the world. System and hypothesis have much the same signification, unless perhaps hypothesis be a more particular system, and system a more general hypothesis. The three most celebrated systems of the world are the Copernican, the Ptolemaic, and Tychonic.

SYSTOLE, in anatomy, the contraction of the heart, whereby the blood is drawn out of its ventricles into the arteries; the opposite state to which is called the diastole, or dilation of the heart.

SYZYGY, in astronomy, a term equally used for the conjunction and opposition of a planet with the sun. On the phenomena and circumstances of the syzygies a great part of the lunar theory depends. For, 1. It is shown in the physical astronomy, that the force which diminishes the gravity of the moon in the syzygies, is double that which increases it in the quadratures: so that in the syzygies, the gravity of the moon, from the action of the sun, is diminished by a part which is to the whole gravity as 1 to 89,36: for in the quadratures, the addition of gravity is to the whole gravity as 1 to 178,73. 2. In the syzygies, the disturbing force is directly the distance of the moon from the earth, and inversely as the cube of the distance of the earth from the sun. And at the syzygies, the gravity of the moon towards the earth, receding from its centre, is more diminished than according to the inverse ratio of the square of the distance from that centre. Hence, in the motion of the moon from the syzygies to the quadratures, the gravity of the moon towards the earth is continually increased, and the moon is continually retarded in its motion; and in the motion from the quadratures to the syzygies, the moon's gravity is continually diminished, and its motion in its orbit accelerated. 3. Further, in the syzygies, the moon's orbit, or circle, round the earth, is more convex than in the quadratures, for which reason the moon is less distant from the earth at the former than the latter. When the moon is in the syzygies, her apsides go backwards, or are retrograde.

When the moon is in the syzygies, the nodes move *in antecedentia* fastest: then slower and slower, till they become at rest, when the moon is in the quadratures.

Lastly, When the nodes are come to the syzygies, the inclination of the plane of the orbit is least of all. Add that these several irregularities are not equal in each syzygy, but all somewhat greater in the conjunction than in the opposition.

T.

T, Or t, the nineteenth letter, and fifteenth consonant, of our alphabet, the sound whereof is formed by a strong expulsion of the breath through the mouth, upon a sudden drawing back of the tongue from the fore part of the palate, with the lips at the same time open. The proper sound of this letter is that in *tan*, *ten*, *tin*, &c. When it comes before *i*, followed by a vowel, it is sounded like *s*, as in *nation*, *potion*, &c. When *h* comes after it, it has a twofold sound; one clear and acute, as in *thin*, *thief*, &c. the other more obtuse and obscure, as in *then*, *there*, &c.

TABBYING, the passing a silk or stuff under a calendar, the rolls of which are made of iron or copper, variously engraven, which, bearing unequally on the stuff, renders the surface thereof unequal, so as to reflect the rays of light differently, making the representation of waves thereon.

TABERNÆMONTANA, in botany, so named in memory of James Theodore, surnamed Tabernæmontanus, from Berg Za-

bern, the place where he was born; a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Apocinæ, Jussieu. Essential character: contorted; follicles two, horizontal; seeds immersed in pulp. There are nineteen species, among which we shall notice the T. cymosa, cyme-flowered tabernæmontana; this is an elegant upright little tree, or shrub, about six feet in height; leaves acute, quite entire, scarcely waved, half a foot long. Cymes ample, handsome, convex, axillary; flowers without scent, dirty white, or reddish brown, about forty in a cyme; tube of the corolla, quinquangular, ventricose at the base; stamens in the enlarged base of the tube; stigma margined at the base; follicles oblong, very blunt, curved in, very large, reddish, with rust-coloured spots; one of each pair is commonly abortive; the pulp is orange-coloured. It is found in the woods and coppices about Carthagena in New Spain, flowering in July and August.

TABES *dorsalis*, in medicine, a distemper which, according to a late author, is a particular species of a consumption, the proximate cause of which is a debility of the nerves.

TABLE, in perspective, denotes a plain surface, supposed to be transparent, and perpendicular to the horizon. It is always imagined to be placed at a certain distance between the eye and the objects, for the objects to be represented thereon, by means of the visual rays passing from every point thereof through the table to the eye; whence it is called perspective-plane.

Table, among the jewellers. A table-diamond, or other precious stone, is that whose upper surface is quite flat, and only the sides cut in angles; in which sense a diamond, cut table-wise, is used in opposition to a rose-diamond.

Table is also used for an index or repertory, put at the beginning or end of a book to direct the reader to any passage he may have occasion for: thus we say, table of matters, table of authors quoted, &c. Tables of the Bible are called concordances.

Table, in mathematics, system of numbers calculated to be ready at hand for the expediting astronomical, geometrical, and other operations: thus we say, tables of the stars; tables of sines, tangents, and secants; tables of logarithms, rhumbs, &c.; sexagenary tables; loxodromic tables &c.

TACCA, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Coronariæ. Narcissi, Jussieu. Essential character: calyx six-parted; corolla six-petalled, inserted into the calyx, anther bearing; stigma stellate; berry dry, hexangular, many-seeded, inferior. There is only one species, *viz.* T. pinnatifida; the root of which is tuberous, composed of many tubers heaped together, here and there emitting fibres; radical leaf subsolitary, petioled, ternate, or biternate; leaflets laciniate pinnatified, acute, spreading, decurrent a little along the sides of the petiole, a foot in length; scape half a fathom in height, herbaceous, fistular, grooved towards the top, erect; umbel terminating, sessile; peduncles four to eight; anthers twelve, on short filaments; germs three, or one three-lobed; styles three, short: stigma obcordate, two-lobed; berry black; seeds brown. It is a native of the East Indies, China, Cochin China, Banda, and the Society Isles.

TACK, in a ship, a great rope having a wale-knot at one end, which is seized or fastened into the clew of the sail; so is reefed first through the chesse-trees, and then is brought through a hole in the ship's side. Its use is to carry forward the clew of the sail, and to make it stand close by a wind: and whenever the sails are thus trimmed, the main-tack, the fore-tack, and mizen-tack, are brought close by the board, and haled as much forward on as they can be. The bowlings also are so on the weather-side; the lee-sheets are haled close aft, and the lee-braces of all the sails are likewise braced aft. Hence they say, a ship sails or stands close upon a tack, *i. e.* close by the wind. The words of command are, hale aboard the tacks, *i. e.* bring the tack down close to the chesse-trees. Ease the tack, *i. e.* slacken it, or let it go, or run out. Let rise the tack, *i. e.* let all go out.

The tacks of a ship are usually belayed to the bitts, or else there is a chevil on purpose to fasten them.

Tack *about*, in the sea-language, is to turn the ship about, or bring her head about, so as to lie the contrary way. In order to explain the theory of tacking a ship, it may be necessary to premise a known axiom in natural philosophy, "that every body will persevere in a state of rest, or of moving uniformly in a right line, unless it be compelled to change its state by forces impressed, and that the change of motion is proportional to the moving force impressed, and is made according to the right line in which that force is exerted."

By this principle it is easy to conceive how a ship is compelled to turn in any direction, by the force of the wind acting upon her sail in horizontal lines. For the sails may be so arranged as to receive the current of air either directly, or more or less obliquely; hence the motion communicated to the sails must of necessity conspire with that of the wind upon their surfaces. To make the ship tack, or turn round with her head to the windward, it is therefore necessary, after she has received the first impression from the helm, that the head-sails should be so disposed as to diminish the effort of the wind, in the first instant of her motion, and that the whole force of the wind should be exerted on the after sails, which, operating on the ship's stem, carries it round like a weathercock. But since the action of the after sails, to turn the ship, will unavoidably cease when her head points to the windward, it then becomes necessary to use the head-sails to prevent her from falling off, and returning to her former situation. These are accordingly laid aback on the lee-side, to push the vessel's fore part towards the appointed side, till she has fallen into the line of her course thereon, and fixed her sails to conform with that situation.

TACKLE, or TACKLING, among seamen, denotes all the ropes or cordage of a ship, used in managing the sails, &c. In a more restrained sense, tackles are small ropes running in three parts, having at one end a pendant and a block; and at the other end, a block and hook, to hang goods upon that are to be heaved into the ship or out of it. See SHIP.

TACTICS, in their general acceptation, relate to those evolutions, manœuvres, and positions, which constitute the main spring of military and naval finesse: they are the means whereby discipline is made to support the operations of a campaign, and are, in every regular service, studied for the purpose of training all the component parts according to one regular plan or system; whereby celerity, precision, and strength, are combined, and the whole rendered completely efficient. Of military tactics, the Romans may be considered the first nation whose military array could be termed regular, and whose forces maintained that order, which rendered each inferior individual subject to the control of certain subaltern officers commanding small bodies, corresponding with our sections; which being again compacted under officers of a second class, formed small divisions, as in our platoons, or companies; and which divisions being collected under a third class of officers, constituted what we term battalions. The soldiers of ancient Italy were not only inured to great hardships, as a part of their usual exercise, but were taught many evolutions suited to the modes of warfare in those days.

Time has occasioned a considerable change in that particular; for since the invention of gunpowder, our battles have frequently been decided by distant cannonades; and by no means resembled those arduous conflicts in which the heroes of old used to engage, individually contending for the day, and causing the whole field to resemble an infinity of single combats. In this practice all barbarous nations seem uniformly to agree; the sword, the tomahawk, the club, &c. being the chief instruments; though in some instances the javeline, or spear, or the bow and arrow, may be primarily resorted to. Hence such warfare is far more sanguinary than that carried on with fire-arms; which rarely do much execution, unless when aided by artillery, and then only when at such distances as to be within reach of case-shot. It will no doubt surprise most of our readers, but is strictly true, that, taking the average quantity of musket ammunition expended, as a sum to be divided by the number of killed and wounded, not more than one shot in fifty will be found to take effect. Thus, after a battalion of 1000 men may have fired 20 rounds per man, making in all 20,000 discharges of musketry, they will have made terrible havoc if 400 of the enemy be disabled.

Hence we find, that the great features in decisive actions are few indeed; and they depend chiefly on tactics. Thus where a large force is brought to bear upon any particular point, while the enemy is kept in ignorance as to the object in view; or where certain advantages of locality are gained, merely by dint of superior science in the art of conducting troops by the shortest means, and in the greatest order; or where by certain evolutions a small force is made to supply the purpose of a larger, or to resist, independently of intrenchments, &c. a more numerous body; all these evince the presence of the man of tactics, and qualify him for the designation of "an able General."

We have also another branch, which is in a degree secondary, because it depends

greatly on the success of the former; namely, the arrangement, or disposition, of a line, in such manner as may allow each description of force to act with effect: this can be done only when the nature of the service to be performed is suited to the nature of the troops by which it is to be attempted. In this we necessarily mean to restrict the operations of infantry to storming parties, cavalry to champaign operations, and artillery to situations where it can be duly protected, while rendering essential service. Hence the able tactician always arranges his force in such manner, as to allow each to perform its duty without interfering with the evolutions of any other class; and in, what is called, manœuvring his army, never fails to estimate the distances, and the time in which each may execute the assigned duty; so that the whole may coincide with one great intention, and insure success by the accurate execution of its respective functions: were it to be otherwise, the whole must be subject to disorder; one failure often leading to the most serious consequence; the same as is caused by the want of a cog, or tooth, of any wheel in a piece of machinery. From this it may be seen how great a superiority that commander must possess who, by means of this science, fully comprehends the most ready arrangement of troops, where change of position becomes necessary; and who has, in the first instance, so disposed them as to be able to make those changes (even under the disadvantages ever attendant upon such necessity) with celerity, and in good order.

But, however skilful the commander, the whole of his good qualities will be abortive unless the materials wherewith he is to perform his part be duly prepared in every respect. It is indispensably requisite, that every individual soldier should be so far trained, as to comprehend fully the general intention of every internal service of the company of which he is a part. He must have a complete knowledge of the parade duties, and consider himself as a mere automaton under the guidance of a superior, or disposing, power: he must be cool, obedient, and passive; and he must possess a sufficient share of physical powers, and of activity, to enable his participating in the movements of the company at large. This, which is assuredly a most important matter, nevertheless has been only within a few years properly attended to: it was formerly considered fully sufficient if the soldier could wheel, face about, and fire with correctness; the conducting of a regiment through its evolutions during an engagement being left entirely to its commander. It is true, the pageantry of home duties was rather ostentatious, and wondrous pains were taken to go through a review with eclat; but the drum and fife were considered indispensable; without them the soldier could not preserve the cadence; he had no regulated length of pace—no regulated time for various evolutions. Now, that we see how much the whole depends on its parts, each individual is trained systematically, and enters the field fully qualified to act without more instruction, at the moment, than is needful to convey to the corps at large the general intention: this not only prevents confusion, but gives to each a certain confidence, both in his comrades and in himself. Habituated to certain regulated paces, independent of musical bias, each soldier preserves his situation with correctness, and feels himself, in all situations, fully competent to fulfil the orders of his officer.

We shall endeavour to explain, in as brief terms as the subject may admit, the manner in which the British forces are now trained; commencing with the first stages of the recruit's tuition, and proceeding, in a regular course, through the operations of companies, battalions, and lines; whereby the chain of connection will be best preserved, and the whole be duly exhibited. The following preamble, taken from the "Rules and Regulations for Formation, Field-Exercise, and Movements, of his Majesty's Forces," is so admirably suited to our purpose, that we present it to our readers as the best preparation we can afford:

"The great object in view is, one general and just system of movement, which, directing the government of great as well as of small bodies of troops, is to be rigidly conformed to, and practised by, every regiment in his Majesty's service. To attain this important purpose, it is necessary to reconcile celerity to order; to prevent hurry, which must always produce confusion, loss of time, unsteadiness, irresolution, inattention to command, &c.; and to insure precision and correctness, by which alone great bodies will be able to arrive at their object in good order, and in the shortest space of time; to inculcate, and to enforce, the necessity of military dependence, and of mutual support in action, which are the great ends of discipline; to simplify the

execution, and to abridge the variety of movements, as much as possible, by adopting such only as are necessary for combining exertions in corps, and that can be required or applied in service, regarding all matters of parade and show merely as secondary objects; to ascertain to all ranks the part each will have to act in every change of situation that can happen, so that explanation may not retard at the moment the execution that should take place; to enable the commanding officer of any body of troops, whether great or small, to retain the whole relatively, as it were, in his hand and management, at every instant, so as to be capable of restraining the bad effects of such ideas of independent and individual exertion as are visionary and hurtful, and of directing them to their true and proper objects, those of order, of combined effort, and of regulated obedience, by the united force of all which, a well disciplined army can only be defeated. The rules laid down will be found few, simple, and adapted to the understanding of every individual; but they will require perfect attention in all ranks. In the soldier, an equal and cadenced march, acquired and confirmed by habit, independently of music or sound: in the officer, precision and energy of command; the preservation of just distances; and the accurate leading of divisions on given points of march and formation. These circumstances, together with the united exertions of all, will soon attain that precision of movement, which is so essential, and without which valour alone will not avail."

After this, the work in question proceeds to state: "The recruit must be carried on progressively; he should comprehend one thing before he proceeds to another, and he should not be uselessly fatigued; he is to be trained singly and in squad; nor is he to be allowed to join in battalion until he may be confirmed in every requisite; for one awkward man will frequently derange a whole line." The incipient parts of instruction, however simple they may appear, are by far the most difficult to inculcate; but they are of the most imperious consequence: when a good foundation is obtained, the work will proceed with rapidity and firmness, and the pupil will, from being sensible how much he has acquired at the onset, move and act, throughout the ulterior stages, with promptitude and confidence. Standing perfectly silent and motionless, fixing his eyes steadily either to the front, or to the right or left, as may be ordered; dressing up to the same line with others; carrying his body erect, the toes turned out, the limbs firm, but pliant, erect, raised, and his weight rather borne on the fore, than on the hind, parts of the feet, are all matters tending greatly to his perfection. He learns to face to the right and left, or about; to move forward in a perfectly straight line, without losing squareness to the front; to move obliquely to the right or left under the same precaution; and to mark time, to step out, or to step short; to change feet when he does not move with the rest of the company; to close, (or take room,) to the right or left, by the side step; to change from quick to ordinary time, or *vice versa*, with unerring readiness; to march in file; to wheel either forward or backward; and, in general, to acquire a habitude of acting in concert with his companions in arms, so as not only to avoid embarrassing them, but proving a firm support, and becoming a manageable tool in the hands of his officer. All these are indispensably necessary to be fully acquired: they must be so perfectly familiar as to seem rather the effect of instinct than of education.

Thus much being duly attained, the recruit is instructed in the use of arms, in which he cannot be too perfect: the great difficulty is to impress him, in a sufficient manner, with the advantages of close motion, and of preserving the body from distortion, or change of position, so far as relates to uprightness, squareness to the front, and undeviating attention to dressing in line. For it is to be observed, that unless very great strictness be observed on the part of the drill serjeant, the whole course will be perverted by the handling of the musket. It would not suit our purpose, nor could it be equal to the views of our readers, were we to enter upon all the details, regarding the motions of the firelock; or what is called the manual exercise: in the present posture of political affairs, such would be perhaps unnecessary; it having, within these few years, become the duty of many, and the amusement of all, to acquire some knowledge of that branch of discipline: we shall therefore proceed to treat of the firings, which constitute a very principal part of the soldier's duty, and greatly interest both the officers commanding divisions, and those in charge of whole battalions. We must, at the same time, express our hope, that the frivolous practice of expending so many rounds of light cartridges, will be in time much curtailed; in order to

make way for a more extended practice with ball; the propriety of enforcing a correctness of aim must be self-evident; and is considerably enhanced by the little execution done by musketry, as has already been shown.

Troops are drawn up in two or three ranks, according to the nature of the service on which they are to be employed, or the enemy to which they are to be opposed. To resist the charge of cavalry, it is found that three ranks are preferable; as is also the case where an enemy advances *en masse*, or bears down in column; in this arrangement, the front being diminished one third, many objections may be urged under local circumstances, especially when acting behind entrenchments, when covered by morasses, or when the enemy cannot advance with rapidity in compact heavy bodies. The mode of drawing up in two ranks is peculiarly adapted to the foregoing, and on some occasions must be adopted, in spite of every adverse argument, for the purpose of extending a front; add to this, that both the round and the grape shots, from the enemy's artillery, do less execution among two, than when three ranks are opposed to them. When a battalion is drawn up in two ranks, they both fire standing; but when in three ranks, only the two rear ranks fire, whilst the front kneels, and presents a formidable impediment to the charge of an enemy, both by its reserved fire, and by its line of sloped bayonets.

According to our improved system of discipline, one officer and one covering serjeant perform all the evolutionary duties of each company, when formed in line; the rest being disposed of in the rear, for the purposes of keeping the men to their duty, and of being in readiness to take command of those lesser portions into which the companies occasionally break. By this arrangement the utmost precision is secured; especially as select men are placed on the flanks of all the companies, also of their sub-divisions and sections, whose duty it is to regulate their wheelings, or changes of locality, by constantly preserving the distances and alignements of their respective portions.

Perhaps among the greatest improvements of the day, we may count the modern method of marching by files; formerly this was effected in a kind of open order, the leaders gradually gaining distance, so as to give a greater space between the files, under the apprehension of treading on each other's heels; but it is now the practice to make every soldier retain the same distance on all occasions from his neighbours; by which means, the right leg of one crosses at the side of the left leg of the other, and *vice versa*. It is obvious, that while the leaders were allowed to gain ground, so as to open the distances between the several files, some time was required for the rear files to close up after the front had halted; and, that if the battalion were to be ordered to front, while in the act of marching by files, under the old system, it would appear of double its due extent: for they would be so distant as to allow space for an additional file between every man in the ranks. Our readers cannot fail to perceive the high importance of keeping troops always to the same extent of front as when formed in line; for if allowed to vary, from any inattention to regularity, it would be utterly impossible for the commander to perform his evolutions upon a given scale; or for any dependance to be placed on the exertions of a line, (particularly in resisting a charge), of which the solidity, that is, the compactness, could not be ascertained.

The extreme difficulty which prevails in the ordinary course of actual service, in keeping the due distances between marching files, has in a great measure rendered that mode obsolete; besides, the facility with which troops move in small divisions, or even by whole companies, in column, &c. whereby intervals are left between them, tending greatly to the convenience and ease of the men, certainly gives the latter mode every claim to preference, except under particular local circumstances. But even in proceeding by files, it is best to march by fours, causing the files to be doubled previous to stepping off. By this means, the whole corps is broken into ranks of four men each, with one space interval between the several ranks. A battalion, thus arranged, is formed in an instant, by the files resuming their places. Yet it cannot be said that this method is so eligible as that of marching by divisions, especially when consisting of only two ranks; in such case the front rank moves on with perfect freedom, each man seeing the obstacles he is to surmount many paces before he arrives at them; and the rear rank, keeping a well opened distance, is considerably liberated, in consequence of the great interval behind it. Add to this, the promptness with which the line can be formed either to the right or left, by the several divisions wheeling up accordingly.

We shall now proceed to show the operations of a body of men according to the existing regulations, illustrating the several movements by means of figures, which will be found in Plate XV. Miscellanies: they will suffice to give a general idea of the evolutions of armies on a large scale, as well as of small parties, the principles of motion being the same in both.

The first matter requiring consideration is the act of wheeling, which may be performed either to a given point, say to the right; or on a given point, say on the left; in either case the front will be to the right. But when a body of men has wheeled to the right, as A, in fig. 11. changing place to B, and that it be required to wheel up into line, *i. e.* to the left, such body will have gained both to the right and to the front equally; the intermediate angle being 90°, and the third position, C, standing at an angle of 45° from the position, A. Consequently a succession of wheeling, to the right and left alternately, will occasion the several positions, in succession, to represent an *escalier*, or flight of steps. It requires, therefore, but little demonstration to show the utility of wheeling backward on the left, in the first instance, to proceed along an alignement, O Q; because the troops, by wheeling to the left, would always come up to the line of their left hand pivots (or files.) Simple as it may seem, this precaution is not yet sufficiently understood, or, at least, not invariably attended to; whereby many oblique movements are made to remedy the error thus generated.

But troops do not always make a full wheel, *i. e.* of 90°, in many instances, as in fig. 12; where an oblique position, D, is to be taken, the whole line, F, wheels by small divisions, only an octave, *i. e.* the eighth of the circle, corresponding with 45°, and thus show a succession of fronts, like the teeth of a saw, all parallel to the new position of 45°. This is called *eçhellon* (a French term, signifying the steps of a ladder). Where the angle of the new position is more or less acute than 45°, the wheel may be made to correspond nearly therewith; so that, when the different divisions march to their several places in the new line, they may move fully to their fronts, and come up square into their places. Where the ground is bad, and that file marching is necessary, the line may wheel to the right in *eçhellon*, to the requisite angle, to point the left flanks of the divisions to their proper situations in the new line, F. When the right or left flank of a corps is the pivot for the new direction, it becomes a *point d'appui*, and the division nearest thereto is arranged properly upon the new line, where it remains as a guide for the others, which, arriving in succession, prolong the new front. The *eçhellon* movement may be considered peculiarly safe, at the same time that they are rapid and regular; the line may be formed instantly, provided the leaders of the several divisions preserve their appropriate distances.

It is to be remarked, that *eçhellon* movements may be made in any direction, whether to front or rear; the divisions wheeling to front or rear accordingly; thus, in fig. 13, which represents a change of from G to H, as the new direction runs through the old one, those divisions which are to be in front wheel forward, while those which are to be in the rear of the first position, G, face about, and wheel towards the rear; observing that the whole wheel the same way, *i. e.* to the right. The two companies nearest the line, H, may be previously posted thereon to advantage, so as to be settled by the time the word is given for the others to march. When those of the rear have come to their places, they face about to the front, and dress. And here it is necessary to remark, that the exterior flank of every company, after been settled in its post, become the *point d'appui* for the next which is to arrive, and to place itself on that flank; but that the officer always looks from the *point d'appui* towards some object, such as a banneret, or a staff officer, &c. fixed as a guide for the alignement, at that point, which is to be on the flank, as at S S in this example.

The column, which is one of the most frequent and important figures of the tactic system, may be found in a variety of modes; the most ordinary is by wheeling, either wholly, or in *eçhellon*; but it is often useful to form it, by the march of divisions in files towards their posts, as shown in fig. 14. When this is done, three files (the leading ones) of each division turn towards their new stations, at which their several pivotmen are ready placed; the whole, when ordered, march towards those men, and when the division, on which the column forms, is duly covered, each company, in succession, fronts in conformity with that division.

This figure shows a battalion, &c. forming upon its sixth company, the left in front; to effect this, the five divisions, on

the right, file from their left flanks, and proceed to place themselves behind the sixth company; while the two companies of the left, file from their right flanks towards the front, and cover. Our readers will perceive, that this is on the same principle as the change of front already described; in fact, the formation of a column is tantamount thereto; it being obvious, that the one unavoidably prepares for the other. In this we suppose the operation to be done in a proper manner; for a column may be easily formed, having its flanks reversed, so that, when ordered to wheel up into line, the flanks of companies will all be misplaced; this is called, "clubbing a battalion," meaning, that it is thrown into a state of confusion.

The column may, with great advantage, be formed from the centre of a battalion, the colours moving forward, supported by the two adjunct companies, the residue of each wing facing inwards, and following its respective leading company. Thus the whole will exhibit a column of grand divisions, each of which is formed of a company from either wing. When the column is to be of only one company in width, the reserve leads off with the colours, and the companies of either wing follow alternately; in this manner the ten companies will all be separated. To form the line from such a column, it is usual either to face the whole outward, excepting the leading division, and causing each to move out direct to the direct parallel of its place in line, order them respectively to front, and move up in succession: or upon the whole facing outward, they may be led by files to their several stations. When the column is in narrow bounds, from which it cannot deploy (or unfold) in either of the above modes, the centre must halt, or step short, while the several divisions close up thereto, and then wheel, or face, to the right and left, according to the wings they may belong to, and countermarch along the rear until they arrive opposite to their respective stations in line. Fig. 15, shows the deploy from a column of grand divisions; the companies of the right wing proceeding straight forward to their parallels; the companies of the left wing leading by files into line. Fig. 16, shows a column of companies alternately from the right and left wings; the right wing making a half wheel into *eçhellon* of whole companies, which as they arrive at the *point d'appui* dress up into line; the companies of the left wing not having space for deploying, move up nearly to the rear of the centre, wheel to left, countermarch along the rear of those divisions which precede them respectively, and arriving at the *point d'appui*, wheel to the right into line.

The column of grand divisions cannot always proceed; otherwise it would be by far the most eligible for the march of single battalions, in situations where the enemy's cavalry might make an attack; the grand divisions should all close up to half distance, so that when ordered to wheel up and form the square, they might leave no gap in either of the flank faces; the two rear companies moving up to the spot on which the grand division immediately preceding them wheeled off, right and left; the front companies, halting during the wheel, and closing up to the centre as the reserve, with the colours, passes into their rear. When there are guns with a battalion, they move on such occasion to the angles most liable to be attacked; four pieces of cannon are needful to render a square perfectly safe; but, for their accommodation, it will be necessary for each face to move forward seven paces; whereby the interior of the square will be greatly increased, and space given for the cannon to be served at the angles; this evolution is exhibited under fig. 17.

The column *en potence*, that is in form of a gibbet, is peculiarly deceptive; especially when that column is a close one, having no intervals between the companies; in this the whole form one solid mass. If discovered, the enemy will certainly direct their artillery towards it; thereby doing great execution. The great object of this formation is to push forward a strong force against some particular point, so as to bear down whatever opposes it, or suddenly to form a flank where a charge of cavalry is expected; in the latter case, the rear division of the column halts until there is space enough for it to wheel, (to the right, if to secure the right flank) and, as each division does the same in succession, it is evident a line is formed, at right angles with the front line, which keeps moving on until all the divisions of the column have wheeled. We have shown, in fig. 18, how this is done on the right flank; while on the left we have shown an *eçhellon* flank, which moves with more ease than the close column, and is not subject to so much mischief from the enemy's artillery; but this is not so deceptive; however it affords the ad-

vantage of being ready either to form a flank, by wheeling backwards an octave, or to move forward into line, which cannot be done from a close column without deploying.

When a column is advancing towards an enemy, it is proper that its cannon should precede it, to clear the way by their fire, but when retreating, the cannon should be in the rear, to check pursuit. The passage of rivers is generally conducted on the same principle, adverting to one point, where a choice can be made, *viz.* always to cross at a re-entering bend of the stream, as shown in fig. 19, by reference to which it will be seen, that in crossing from A to B, the passage cannot be flanked by the enemy, while it is defended by the troops which first cross: change the position, and cross from B to A, and the enemy will flank the passage, which you cannot defend, because they will enfilade whatever troops or cannon you post for that purpose, they having the command of a greater extent of front than yourself in the latter instance.

One of the most arduous situations in which an officer can be placed is the covering, or conducting, of a convoy, especially when heavy carriages are in question. A numerous convoy can rarely travel more than six or seven miles within the day, however favourable the roads may be, unless it may be practicable to draw two or three carriages abreast, which can be practicable on plains only, for whenever a pinch or defile might present itself, so as to occasion only one carriage to proceed at a time, though only for a few feet, as in passing a narrow bridge, it would have the same effect as if the whole day's journey were performed in single trains. this is not the case in champain situations, because one column of waggons may keep moving on while another is stopt, and, if a carriage should break down, others may pass round it in this way the columns should not be far distant. When we consider that a hundred waggons will cover a mile in length, we cannot but admire the frequent success of officers, perhaps with only four or five battalions under their command, in conducting convoys of many hundreds of heavy carriages, through an exposed country, from one place to another, sometimes, indeed, for full an hundred miles. On such service it is highly necessary to have a body of cavalry; else every little party of the enemy's horse would subject the convoy to perpetual danger and delay.

When a general expects a convoy, he must favour its approach and safety by every possible means. one of the best devices is, that of threatening an attack, so as to prevent the enemy from detaching his cavalry. When the convoy is near, and it is suspected that an attempt will be made to cut it off by a sudden movement, the general must, if circumstances admit, make one retrograde march with his whole force to meet it, or, if that be not practicable, he may send orders for it to follow such route as may be most under cover, or best removed from the danger of assault. We often see instances of a campaign being decided by the safe arrival, or *vice versa*, by the loss of, a convoy. The utmost skill sometimes cannot oppose the overbearing prowess of superior power, but, as we always suppose an army to place itself between its expected supplies and the enemy, it is evident, that if of equal force, every advantage is on its side, for the enemy, having a greater distance to march, when about to attack a convoy, than the defenders have to proceed to its rescue, and any detached party being liable to destruction while passing round the flank, it is evident, that by retaining the intermediate situation, we may generally afford every necessary protection. When it happens otherwise, we commonly find, that the enemy are superior in cavalry, which they detach to a great distance to intercept the convoy, while their infantry remains in some strong position. In such case a retreat is indispensably necessary, and reliance must be placed in the commander of the convoy, (if he is warned of the enemy's approach) being able either to take refuge under the walls of some fortified place; or, on his taking possession of some village, or forming a barrier against the enemy, by drawing up his waggons, &c. to the best advantage: in such case he is virtually entrenched, his cattle and troops being within an area impenetrable to cavalry, and furnishing an excellent cover for the keeping up a most destructive fire on the assailants. If he can command a supply of water, he may do wonders, at all events, he may easily hold out until relieved.

A retreat, well managed, is usually more favourable than a dear earned victory. To insure the means of retreating, without considerable loss, a second, or even a third, line may be requisite: at all events, a reserve of select troops, with a good park of artillery, chiefly supplied with grape and

case-shot, will be indispensable. The posting a reserve requires great judgment, both in regard to the enemy's designs, and the temper of your own troops.

The celebrated retreat of Moreau, through the Black Forest, placed him, *ipso facto*, on a footing with the greatest conquerors of the day; it tore from his opponent's brows those laurels which the latter claimed, in consequence of having urged the French general to quit the open country. In that instance, however, it may, perhaps, be said, and not without some show of justice, that the nature of the country was greatly in favour of the latter; but, on the other hand, it must be taken into account, that, unless most skilfully managed, a retreat before a very superior force must have been peculiarly dangerous, especially to the cavalry: we may, indeed, admire that system of tactics, which enabled Moreau to save his artillery and baggage. To do this, it is evident he must have shown a firm front, so arranged, that his opponent dared not to venture an attack. The excellence of the manœuvre consisted in the deceptions practised; for it was not until that movement, when Moreau had secured his baggage and artillery, and, as it were, buried his army among the wildernesses, that the Austrian general could believe it possible for the French to escape being captured. The device used, was a feint to escape along the skirts of the forest, which occasioned a change of position in the Austrian camp, and left Moreau at liberty to push in the opposite direction towards a pass, scarcely, indeed, passable for carriages, and thus to defy pursuit; however it answered his purpose, for he escaped with his whole army.

We cannot close this article without showing how essentially a well chosen position contributes to success. Where an army is weak in cavalry, it should invariably be parted so that, at least, one of its flanks may be covered from the enemy's horse. By this means, if its own cavalry be held in reserve, or nearly so, but with full powers to support the open wing, the enemy must be kept in suspense, as to the point to which it will direct its charge; and be compelled, in many instances, to keep his horse divided, for the purpose of opposing that charge on either flank. A flank may be securely covered by a town, duly defended by infantry; or by a river; a morass; a thick wood; a steep hill, having a battery duly posted; or even by broken ground. In some instances, a slight intrenchment may be necessary.

TACTICS, *naval*, relate to those operations in the management of a vessel, which enable her to attain any particular object, such as reaching a port, avoiding danger, gaining an advantage over an enemy, &c. In a more extended sense, they denote those manœuvres, stratagems, and deceptions, employed by the commander of a fleet, for the purpose of gaining a weather-gage, cutting off any part of a line, or attacking any particular portion thereof, in such manner as may either defeat the views of a hostile fleet, or subject it to loss and discomfiture. The old system of tactics in this, as well as in the military branch, was burthened with ceremonies, and with received opinions, which were held to be inviolable: the difference of one or two ships in favour of the enemy, was considered a sufficient excuse for a variety of precautions generally amounting to forbearance from engaging the superior power; and, although we certainly can count a number of gallant exploits performed by our fleets when somewhat inferior to the enemy, it has been reserved for latter times to exhibit what could be done by the British navy, even when opposed to nearly double their own force. This wonderful change was introduced by Rodney; who, in the year 1782, engaged the French fleet under Count de Grasse; when by boldly cutting off a part of its rear, he compelled nearly half the enemy's force to surrender; the rest sought their safety in flight. Since that date, Admiral Jervis, by a skilful manœuvre, cut off a large portion of a Spanish fleet, near Cape St. Vincent's, (whence the peerage bestowed on him received its designation;) but the late Lord Nelson appears most conspicuous in that mode of attack which, in general, secured a victory. The battle of the Nile was doubtless a master piece of tactical science; it merits notice from its simplicity, and, if we may be so bold as to use the term, its infallibility. The manœuvre he used was, to throw two of his ships upon every one of the weather-most of the enemy's line, by causing his fleet to divide as it approached them; consequently including each French ship between two of ours. The residue, which were moored in a line a-head, fully expected to see ours range up their whole length, and oppose ship to ship. They saw their error when it was too late; being to leeward, it was impossible for them to render efficient aid,

and they fell in detail; with the exception of a very small portion, which escaped by putting out to sea, whither we were not in a condition to follow with any hopes of overtaking them. See fig. 20.

In the famous battle of Trafalgar, in which the immortal Nelson quitted his earthly frame, the combined fleets were drawn up in the form of a crescent, and awaited our attack, which was made in a double column, apparently bearing down upon their centre. This novel mode of coming into action kept the enemy completely in suspense: it threatened every part of their line. If our two columns had turned the same way, they would have been able to do infinite damage in that quarter, before the other wing of the enemy could come up to succour their overpowered friends: if the two columns should cut through the centre, they must destroy it, and effectually separate the two wings, so as to leave them ignorant of each other's fate. Such was the fact: the enemy, though superior in numbers, lost no less than nineteen sail of the line. The reader may form some conception of that glorious event by a reference to fig. 21.

Perhaps nothing can place a fleet in a more dangerous state, and render it less able to resist an attack, than making sail before the wind, in a line of battle a-head, to avoid a pursuing enemy. In such a case, whenever the rear of that line can be brought to action, it becomes subject to an accumulating force, in consequence of the pursuing fleet thickening upon it; while the van of its own line, being to leeward, must make many tacks, or at least two long ones, before it can succour its rear. The disadvantage must be very great even if all the ships, on both sides, sail upon an exact equality; but, as that is never the case, many of the flying ships will be probably driven completely to leeward, and never be able to afford the smallest assistance. Yet British seamen, even when compelled to retire before a very superior force, generally manage, by some well contrived device, to intimidate their pursuers, or to put on so good a face, as to convince them of the dear price at which the victory is to be bought. Of this we cannot quote a more appropriate instance than the escape of five sail of our ships, under the command of Admiral Cornwallis, from no less than nineteen sail of French ships of the line: an escape resulting entirely from the manœuvres of the British Admiral; whereby he fully convinced the French that a large force was at hand.

The present unparalleled state of discipline, throughout our navy, would, of itself, give us the command of the ocean; but we are greatly indebted, at the same time, to an excellent code of signals, both for the day and the night, whereby every operation and manœuvre, may be directed with readiness and perspicuity. The day signals are, for the most part, made by flags, jacks, and pennants; the night signals by lanterns, blue lights, maroons, &c.: in both, the firing of guns, either to windward or to leeward, occasionally is added. When fleets are large, or their duty extensive, especially in cruizing to intercept a convoy of merchant vessels, &c. there are repeating frigates, which display the several signals made by the commander; so that they may be communicated to all the vessels; every signal being kept flying until answered by all ships to which they may relate.

We shall now offer to our readers some minutiæ relative to the fighting of a ship, under ordinary circumstances; observing, that under the head of NAVIGATION much will be found to instruct the learner in ascertaining a vessel's course, way, &c.; and under the head of QUADRANT what relates to the common mode of taking observations, for the purpose of ascertaining a vessel's locality.

When orders are given to "clear ship for action," the boatswain and his mates whistle, and call, at the various hatchways, to warn all who are between decks: the hammocks, or beds, are instantly unhooked, packed, and sent on deck, to be put into the nettings on the waist, forecastle, quarters, poop, &c. where they serve as an excellent defence against musketry. While some of the seamen are thus employed between decks, others are aloft securing the yards in chain slings, so as to prevent them from falling when the haul-yards may be severed by cannon shot; materials for repairing the rigging are also placed in readiness; shot-plugs, for stopping holes near, or under, the surface of the water, are dispensed; and every attention is paid to ascertain that the pumps are in order, so as to clear the hold in case of leaks. The decks are cleared of every incumbrance, by the removal of chests, &c. into the hold; the various gun-tackles are inspected; and all the necessary implements, such as powder-ladles, worms, rammers, sponges, &c. are duly supplied. All being ready, the sur-

geon and his mate, together with the chest of medicines, instruments, bandages, &c. are prepared in the cock-pit; that is, down the hatchway, below the ordinary reach of the enemy's shot. The officers and men repair to their posts, the powder-room is opened, the hatches are all laid, the marines drawn up on the forecastle, quarter-deck, and poop, the guns are run out and levelled, and the courses, (that is, the lower sails) are clued up, to prevent their being set on fire by the discharges from the cannon; also to render the ship more manageable.

The greatest attention is always paid to taking a good aim before a gun is fired; that every shot may hit some part of the enemy's hull; the nearer to the water's edge the better. The captain, master, purser, &c. remain on deck to fight the ship, and to note down all occurrences, while the signal-master attends to and answers whatever signals may be thrown out by the commander of the fleet, or division. It is ever a primary object to place the ship in such a position as may annoy the enemy most; yet, at the same moment, evade his principal defences: this is best done by laying diagonally upon her quarter, or bow, and especially across her stern, so as to rake her fore and aft; whereby her guns will soon be dismounted, and the men driven from their quarters.

This description of the manner in which the battle is carried on by each ship, will serve as an illustration of the whole; but it may be necessary to add, that the disposition of a fleet must be suited to the position the adversary may have assumed. When an enemy opposes a direct line, opposite to that of his own fleet, the admiral rarely does more than make the signal for line of battle abreast, perhaps a cable's length asunder, thus coming at once to close engagement, ship opposed to ship, or rather the two fleets intermixed alternately, their heads laying different ways: if they should pass each other, it is usual to put about, and resume the engagement in the same manner. When the enemy bear down in a line a-head, it is customary to receive them in the same manner, to prevent their cutting off a part of the line; this depends greatly on the direction of the wind: but if it be on the beam, that is full on the side, or in any direction affording the means of aiding your van, without delay, by a press of sail, such a mode of attack will subject the enemy to have his own line cut, as was done by Rodney; or doubled upon, as in the battle of the Nile.

During an engagement, the courses are commonly hauled up, as before stated; the top-gallant-sails and stay-sails are also furled. The movement of each ship is chiefly regulated by the main and fore-top sails, and the jib, reserving the mizen to fill, or to be thrown aback, as an aid, either to accelerate the ship, or as a check to prevent her passing the enemy. The frigates, tenders, and other small vessels generally lay to, or hover about in the rear, to repeat signals, or to aid crippled ships. These, not being considered as ships of the line, are not attacked, except by vessels of their own class; therefore, when a fleet is not well manned, it is common to take all the spare hands from such to assist on board the fighting ships. When a fleet is superior in numbers, it is proper to keep some of them in reserve, stationing them behind the weaker parts of the line to succour such as may, by the loss of masts, &c. become unmanageable, and to take advantage of any opportunity to chase, and lay aboard of whatever of the enemy's ships may quit the line for the purpose of escaping. In order to observe what is going on, the admiral generally removes to some frigate, on board which he hoists his flag; near him should be some of the best sailing cutters, brigs, &c. to convey orders which could not be accurately delivered by signal, or by telegraph.

Boarding is most commonly resorted to by privateers, in their attacks upon merchant vessels; but among ships of the line is rarely practised. Our commanders are perhaps more forward than those of any other nation, except the Turks, in this kind of enterprize, which is replete with hazard. The best mode of boarding, especially if there be any swell, is to keep on the enemy's weather quarter; now and then, if the sailing of your ship will allow, yawing, so as to throw your fire into her stern: when, by this means, you have done any execution, it will be proper to pass close under the enemy's stern, raking her fore and aft with your guns double shotted, and then lay her aboard upon her lee beam, having your tops well manned to fire upon the enemy's decks, on which also grenades, stink-pots, fire-balls, &c. should be discharged. Having grappled the ship to your adversary's chains, your boarders jump into her, under the cover of the fire of your small arms. In case of repulse,

the attack to leeward is most favourable to the retreat of your men; besides, it is far easier to cast off from the enemy, than it would be if you were to windward of her.

TÆNIA, in natural history, *tape-worm*; body flat, and composed of numerous articulations: head with four orifices for suction, a little below the mouth: mouth terminal, continued by a short tube into two ventral canals, and generally crowned with a double series of retractile hooks or holders. Gmelin has enumerated almost one hundred species, besides varieties: he has divided them into sections. A. Those found in other parts besides the intestines, and furnished with a vesicle behind. B. Those found in the intestines only, and without a terminal vesicle. C. Those with the head unarmed with hooks. The worms of the first section are found infesting Mammalia, reptiles, and fish. Those of the second section are found in the Mammalia, in birds, and in fish; and those of the third section infest Mammalia, birds, reptiles, and fish. This genus of worms are destined to feed on the juices of various animals, and are usually found in the alimentary canal, generally at the upper part of it. They are sometimes found in great numbers, and occasion the most distressing disorders. They have the power of reproducing parts which have been broken off, and are therefore removed with the utmost difficulty: they are oviparous, and discharge their eggs from the apertures on the joints. We shall give a few of the more remarkable species.

1. T. visceralis, which is inclosed in a vesicle, broad in the fore part, and pointed in the hinder part; inhabits the liver, the placenta uterina, and the sac which contains the superfluous fluid of dropsical persons. 2. T. cellulosa, which is inclosed in a cartilaginous vesicle, inhabiting the cellular substance of the muscles; is about an inch long, half an inch broad, and one-fourth of an inch thick, and is very tenacious of life. 3. T. dentata, has a pointed head; the large joints are streaked transversely, and the small joints are all dilated; the osculum or opening in the middle of both margins is somewhat raised. It is narrow, ten or twelve feet long, and broad in the fore parts: its ovaria are not visible to the naked eye; and the head underneath resembles a heart in shape. It inhabits the intestines. 4. T. lata, is white, with joints very short and knotty in the middle; the osculum is solitary. It is from eighteen to one hundred and twenty feet long; its joints are streaked transversely; its ovaria are disposed like the petals of a rose. 5. T. vulgaris, has two lateral mouths in each joint; it attaches itself so firmly to the intestines, that it can scarcely be removed by the most violent medicines; it is slender, and has the appearance of being membranaceous; it is somewhat pellucid, from ten to sixteen feet long, and about four lines and a half broad at one end. 6. T. truttæ, which chiefly inhabits the liver of the trout, but is also to be found in the intestines of the human species. 7. T. solium, has a marginal mouth, one on each joint. 8. T. ovilla, found in the liver and omentum of sheep. 9. T. celebralis is aggregate; numerous animalcules united by their base to a large common vesicle, distributed about the surface and retractile within it. This is found in vast numbers in the brain, or spinal marrow, immediately beneath the brain of sheep. These noxious animalcules occasion giddiness and staggering, and the disease known by the name of the dunt or rickets: which if the containing vesicle be broken, is incurable; for these minute worms, in size scarcely larger than a grain of sand, are each of them furnished with from thirty-two to thirty-six hooks on the head, by which they fix themselves firmly to the substance of the brain, or its coats.

The structure and physiology of the tænia are curious, and it may be amusing as well as instructive to consider it with attention. The tænia appears destined to feed upon such juices of animals as are already animalized; and is therefore most commonly found in the alimentary canal, and in the upper part, where there is the greatest abundance of chyle; for chyle seems to be the natural food of the tænia. As it is thus supported by food which is already digested, it is destitute of the complicated organs of digestion. As the T. solium is most frequent in this country, it may be proper to describe it more particularly.

It is from three to thirty feet long, some say sixty feet. It is composed of a head in which are a mouth adapted to drink up fluids, and an apparatus for giving the head a fixed situation. The body is composed of a great number of distinct pieces articulated together, each joint having an organ by which it attaches itself to the neighbouring part of the inner coat of the intestine. The joints nearest the head are al-

ways small, and they become gradually enlarged as they are further removed from it; but towards the tail a few of the last joints again become diminished in size. The extremity of the body is terminated by a small semicircular joint, which has no opening in it.

The head of this animal is composed of the same kind of materials as the other parts of its body; it has a rounded opening at its extremity, which is considered to be its mouth. This opening is continued by a short duct into two canals; these canals pass round every joint of the animal's body, and convey the aliment. Surrounding the opening of the mouth are placed a number of projecting radii, which are of a fibrous texture, whose direction is longitudinal. These radii appear to serve the purpose of tentacula for fixing the orifice of the mouth, as well as that of muscles to expand the cavity of the mouth, from their being inserted along the brim of that opening. After the rounded extremity or head has been narrowed into the neck, the lower part becomes flatted, and has two small tubercles placed upon each flatted side; the tubercles are concave in the middle, and appear destined to serve the purpose of suckers for attaching the head more effectually. The internal structure of the joints composing the body of this animal is partly vascular and partly cellular; the substance itself is white, and somewhat resembles in its texture the coagulated lymph of the human blood. The alimentary canal passes along each side of the animal, sending a cross canal over the bottom of each joint, which connects the two lateral canals together.

Mr. Carlisle injected with a coloured size, by a single push with a small syringe, three feet in length of these canals, in the direction from the mouth downwards. He tried the injection the contrary way, but it seemed to be stopped by valves. The alimentary canal is impervious at the extreme joint, where it terminates without any opening analogous to an anus. Each joint has a vascular joint occupying the middle part, which is composed of a longitudinal canal, from which a great number of lateral canals branch off at right angles. These canals contain a fluid like milk.

The tænia seems to be one of the simplest vascular animals in nature. The way in which it is nourished is singular; the food being taken in by the mouth, passes into the alimentary canal, and is thus made to visit in a general way the different parts of the animal. As it has no excretory ducts, it would appear that the whole of its alimentary fluid is fit for nourishment; the decayed parts probably dissolve into a fluid which transudes through the skin, which is extremely porous.

This animal has nothing resembling a brain or nerves, and seems to have no organs of sense but those of touch. It is most probably propagated by ova, which may easily pass along the circulating vessels of other animals. We cannot otherwise explain the phenomena of worms being found in the eggs of fowls, and in the intestines of a fœtus before birth, except by supposing their ova to have passed through the circulating vessels of the mother, and by this means been conveyed to the fœtus.

The chance of an ovum being placed in a situation where it will be hatched, and the young find convenient subsistance, must be very small; hence the necessity for their being very prolific. If they had the same powers of being prolific which they now have, and their ova were afterwards very readily hatched, then the multiplication of these animals would be immense, and become a nuisance to the other parts of the creation.

Another mode of increase allowed to tænia (if we may call it increase) is by an addition to the number of their joints. If we consider the individual joints as distinct beings, it is so; and when we reflect upon the power of generation given to each joint, it makes this conjecture the more probable. We can hardly suppose that an ovum of a tænia, which at its full growth is thirty feet long, and composed of four hundred joints, contained a young tænia composed of this number of pieces; but we have seen young tæniæ not half a foot long, and not possessed of fifty joints, which still were entire worms. We have also many reasons to believe, that when a part of this animal is broken off from the rest, it is capable of forming a head for itself, and becomes an independent being. The simple construction of the head makes its regeneration a much more easy operation than that of the tails and feet of lizards, which are composed of bones and complicated vessels; but this last operation has been proved by the experiments of Spallanzani and many other naturalists.

TAFFETY, in commerce, a fine smooth silken stuff, remarkably glossy. See SILK. There are taffeties of all colours, some plain, and others striped with gold, silver, &c.

others chequered, others flowered, &c. according to the fancy of the workmen.

TAGETES, in botany, *marygold*, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: calyx one leaved, five-toothed, tubular; florets of the ray five, permanent, down with firm erect chaffs; receptacle naked. There are four species, and several varieties: the T. erecta, African marygold, is from three to four feet in height, divided from the middle into many branches, each bearing one large flower; leaves long, pinnate; leaflets dark green; flowers yellow, from brimstone to orange colour; of this there are five varieties, all annuals.

TALC, in mineralogy, is divided into three sub-species, viz. 1. The earthy talc, which is of a greenish white colour, composed of glimmering pearly small scaly parts: it soils a little, and feels rather greasy. It occurs in the tin mines near Freyburg, in Saxony. 2. Common Venetian talc is of an apple green, which passes on one side into greenish white, and even into silver white; on the other, into asparagus green. It is massive, disseminated, and in extremely delicate crystals. It is splendent and shining; feels very greasy, and is easily frangible. It is infusible before the blow-pipe, without addition, and its constituent parts are

Magnesia	44
Silex	50
Alumina	6
	100

This is frequently confounded with mica, from which it is, however, distinguished by want of elasticity, by its greasy feel, and colour. It is almost entirely confined to the primitive mountains, where it occurs in beds, imbedded in serpentine, and also in veins. It abounds in the mountains of Tyrol and Salzburg, hence it is brought to Venice, and on that account has obtained the name of Venetian talc. It is employed as a basis for coloured crayons, and for the finest rouge.

3. Indurated talc is of a greenish grey colour; it occurs massive; lustre shining, passing to glistening, and is pearly; feels rather greasy. It occurs in primitive mountains, where it forms beds in clay, slate, and serpentine. It is thought to be an intermediate link between steatite and potstone, which see. It is found in the Alps, in Stiria, and in Austria, and Hungary; also in some parts of Scotland: the constituent parts are,

Magnesia	38.54
Silica	38.12
Alumina	6.66
Lime	0.41
Iron	15.02
	98.75
Loss	1.25
	100.00

TALENT, money of account amongst the ancients. Amongst the Jews, a talent in weight was equal to sixty maneh, or 113 ℔. 10 oz. 1 dwt. 10 2/7 gr.

TALES, *i. e. tales de circumstantibus*, by-standers, is used in law for a supply of men impannelled on a jury, and not appearing, or on their appearance challenged and disallowed, when the judge upon motion orders a supply to be made by the sheriff of one or more such persons as are present in court, to make up a full jury.

TALLOW *tree*, a remarkable tree growing in great plenty in China, so called from its producing a substance like tallow, which serves for the same purpose; it is about the height of a cherry-tree, its leaves in form of a heart, of a deep shining red colour, and its bark very smooth. Its fruit is inclosed in a kind of pod, or cover, like a chesnut, and consists of three round white grains, of the size and form of a small nut, each having its peculiar capsule, and within a little stone. This stone is encompassed with a white pulp which has all the properties of true tallow, both as to consistence, colour, and even smell, and accordingly the Chinese make their candles of it, which would doubtless be as good as those in Europe, if they knew how to purify their vegetable, as well as we do our animal, tallow. All the preparation they give it is to melt it down, and mix a little oil with it, to make it softer and more pliant. It is true their candles made of it yield a thicker smoke, and a dimmer light than ours; but those defects are owing in a great measure to the wicks, which are not of cotton, but only a little rod of dry light wood covered with the pith of a rush wound round it; which, being very porous, serves to filtrate the minute parts of the tallow, attracted by the burning stick, which, by this means, is kept alive. See TOMEX.

TALPA, the *mole*, in natural history, a genus of Mammalia, of the order Feræ. Generic character; six fore-teeth in the

upper jaw, unequal, eight in the lower; tusks solitary, in the upper jaw larger; seven grinders in the upper, and six in the lower. There are four species.

T. Europea, the common mole, is about six inches in length, without the tail. Its body is large and cylindrical, and its snout strong and cartilaginous. Its skin is of extraordinary thickness, and covered with a fur, short, but yielding to that of no other animal in fineness. It hears with particular acuteness, and, notwithstanding the popular opinion to the contrary, possesses eyes, which it is stated to be able to withdraw, or project, at pleasure. It lives partly on the roots of vegetables, but principally on animal food, such as worms and insects, and is extremely voracious and fierce. Shaw relates, from Sir Thomas Brown, that a mole, a toad, and a serpent have been repeatedly inclosed in a large glass vase, and that the mole has not only killed the others, but has devoured a very considerable part of them. It abounds in soft ground, in which it can dig with ease, and which furnishes it with the greatest supply of food. It forms its subterraneous apartments with great facility by its snout and feet, and with a very judicious reference to escape and comfort. It produces four or five young, in the spring, in a nest a little beneath the surface, composed of moss and herbage. It is an animal injurious to the grounds of the farmer, by throwing up innumerable hills of mould, in the construction of its habitation, or the pursuit of its food, and many persons obtain their subsistence from the premiums which are, on this account, given for their destruction. Moles can swim with considerable dexterity, and are thus furnished with the means of escape in those sudden inundations to which they are frequently exposed. In Ireland, the mole is unknown. See Mammalia, Plate XX. fig. 5.

T. radiata, or the radiated mole, is very similar to the above, from which it is principally distinguished by a circle of radiated tendrils, resembling the ray of a boot-spur, attached to the nose. It is a native of North America. See Mammalia, Plate XX. fig. 6.

TALUS, in fortification. Talus of a bastion, or rampart, is the slope or diminution allowed to such a work, whether it be of earth or stone, the better to support its weight. The exterior talus of a work, is its slope on the side towards the country, which is always made as little as possible, to prevent the enemy's scalado; unless the earth be bad, and then it is absolutely necessary to allow a considerable talus for its parapet. The interior talus of a work is its slope on the inside towards the place.

TAMARINDUS, in botany, *tamarind tree*, a genus of the Monadelphia Triandria class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx four-parted; petals three; nectary of two short bristles under the filaments; legume pulpy. There is only one species, viz. T. indica, tamarind tree, which grows to a large size in those countries, where it is a native; the stem is very large, covered with a brown bark, dividing into many branches at the top, and spreading wide every way; the flowers come out from the side of the branches, five, six, or more together, in loose branches; the pods are thick and compressed, those from the West Indies are from two to five inches in length, containing two, three, or four seeds; those from the East Indies are nearly twice as long, and contain five, six, and even seven seeds; plants raised from both these are so much alike as not to be distinguished; the difference in the size of the pods is probably owing to soil and culture. The calyx is straw-coloured; the petals are yellowish, beautifully variegated with red veins; peduncles half an inch in length, each furnished with a joint, at which the flower turns inwards; filaments commonly three; they are purple, and the anthers are brownish. The timber of the tamarind tree is heavy, firm, and hard; sawn into boards, it is converted to many useful purposes in building. The fruit is used both in food and medicine. In many parts of America, particularly in Curaçao, they eat abundance of it raw, without any inconvenience. In Martinico also, they eat the unripe fruit, even of the most austere kind.

TAMARIX, in botany, *tamarisk*, a genus of the Pentandria Trigynia class and order. Natural order of Succulentæ. Portulaceæ, Jussieu. Essential character: calyx five-parted; petals five; capsule one-celled, three-valved; seeds pappose. There are four species: we shall notice the T. gallica, French tamarisk, which is a native of the south of France, Spain, Italy, Russia, Tartary, Barbary, and Japan, where it grows to a tree of a middling size; in England it is rarely more than fourteen feet in height. The bark is rough, and of a dark-brown colour; it sends out many slender branches, most of which spread out flat, hanging

downwards at their ends; these are covered with a chesnut-coloured bark, and garnished with very narrow, finely-divided leaves, of a bright green colour, having small leaves or indentures, which lie over each other like scales of fish; the flowers are produced in taper spikes, at the end of the branches, several of them growing on the same branches; the spikes are about an inch long, the flowers are set very close all round the spike; they are small, and have five concave petals, of a pale flesh colour, with five slender stamina, terminated by roundish red anthers; the flowers appear in July, and are succeeded by oblong, acute-pointed, three-cornered capsules, filled with small downy seeds, which seldom ripen in England.

TAMBAC, a mixture of gold and copper, which the people of Siam hold more beautiful, and set a greater value on, than gold itself.

TAMBOUR, in architecture, a term applied to the Corinthian and Composite capitals, as bearing some resemblance to a drum, which the French call tambour.

TAMBOUR is also used for a little box of timber-work, covered with a ceiling, within side the porch of certain churches, both to prevent the view of persons passing by, and to keep off the wind, &c. by means of folding doors.

TAMUS, in botany, *black bryony*, a genus of the Dioecia Hexandria class and order. Natural order of Sarmentaceæ. Asparagi, Jussieu. Essential character: calyx six-parted; corolla none: female, style trifid; berry three-celled, inferior; seeds two. There are two species, *viz.* T. communis, common black bryony, and T. cretica, Cretan black bryony.

TANACETUM, in botany, *tansy*, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoidæ. Corymbiferæ, Jussieu. Essential character: calyx imbricate, hemispherical; corolla rays obsolete, trifid, sometimes none, and all the flowers hermaphrodite; down submarginate; receptacle naked. There are nine species, of which the T. vulgare, common tansy, has a fibrous creeping root, which spreads to a great distance; the herb is bitter, possessing a strong aromatic smell. It is a native of Europe and Siberia, in high meadows and pastures, on the banks of rivers, and in swampy places, flowering from June to August.

TANAECIUM, in botany, a genus of the Didynamia Angiospermia class and order: Essential character: calyx cylindrical, truncate; corolla tubular, almost equal, five-cleft; rudiment of a fifth filament; berry corticose, very large. There are two species, *viz.* T. jaroba, and T. parasiticum, both natives of Jamaica.

TANAGRA, the *tanager*, in natural history, a genus of birds of the order Passeres. Generic character: bill conic, somewhat inclining towards the point; upper mandible slightly ridged and notched near the end. There are forty-four species, of which the following deserve the chief attention.

T. jacapa, or the red-breasted tanager, is of the size of a sparrow, and abounds in various parts of America. It feeds on fruits, and frequents gardens. Its nest is of a cylindrical form, fixed to the horizontal branch of a tree, and the entrance is beneath. It is generally seen in pairs.

The T. tatoa, or titmouse of Paradise, is nearly as large as a goldfinch, is one of the most beautiful birds of the genus, adorned with the most brilliant plumage of scarlet, blue, green, and gold. It is found in flocks in Cayenne and Guiana, at the season when a particular, but undescribed, fruit tree is in bearing, and is said to be found, in those countries, only in the immediate vicinity of these trees. It may be confined, and fed on bread and milk; but has no powers of melody.

TANGENT, in geometry, is defined, in general, to be a right line, which touches any arch of a curve, in such a manner, that no right line can be drawn between the right line and the arch, or within the angle that is formed by them. The tangent of an arch is a right line drawn perpendicularly from the end of a diameter, passing to one extremity of the arch, and terminated by a right line drawn from the centre through the other end of the arch, and called the secant. And the co-tangent of an arch is the tangent of the complement of that arch. The tangent of a curve is a right line which only touches the curve in one point, but does not cut it.

In order to illustrate the method of drawing tangents to curves, let A C G, Plate XIV. Miscel. fig. 10, be a curve of any kind, and C the given point from whence the tangent is to be drawn. Then conceive a right line, $m g$, to be carried along uniformly, parallel to itself, from A towards G; and let, at the same time, a point, p, so move in that line, as to describe the given curve, A C G: also let $m m$, or C n, express

the fluxion of Am, or the velocity wherewith the line, mg, is carried; and let nS express the corresponding fluxion of mp, in the position mCg, or the velocity of the point, p, in the line, mg: moreover, through the point, C, let the right line, SF, be drawn, meeting the axis of the curve, AQ, in F.

Now, it is evident, that if the motion of p, along the line, mg, was to become equable at C, the point, p, would be at S, when the line itself had got into the position, mSg; because, by the hypothesis, Cn and nS expresses the distances that might be described by the two uniform motions in the same time. And if vsg be assumed to represent any other position of that line, and s the contemporary position of the point, p, still supposing an equable velocity of p; then the distances, Cv, and vs, gone over in the same time by the two motions, will always be to each other as the velocities, or as Cn to nS. Therefore, since Cv : vs :: Cn : nS, (which is a known property of similar triangles), the point, s, will always fall in the right line, FCS, (fig. 11): whence it appears, that if the motion of the point, p, along the line, mg, was to become uniform at C, that point would then move in the right line, CS, instead of the curve line, CG. Now, seeing the motion of p, in the description of curves, must either be an accelerated or retarded one; let it be first considered as an accelerated one, in which case, the arch, CG, will fall wholly above the right line, CD, as in fig. 10; because the distance of the point, p, from the axis, AQ, at the end of any given time, is greater than it would be if the acceleration was to cease at C; and if the acceleration had ceased at C, the point, p, would have been always found in the said right line, FS. But if the motion of the point, p, be a retarded one, it will appear, by arguing in the same manner, that the arch, CG, will fall wholly below the right line, CD, as in fig. 11.

This being the case, let the line, mg, and the point, p, along that line, be now supposed to move back again, towards A and m, in the same manner they proceeded from thence; then, since the velocity of p did before increase, it must now, on the contrary, decrease; and therefore, as p, at the end of a given time, after repassing the point, C, is not so near to AQ, as it would have been had the velocity continued the same as at C, the arch, Ch (as well as CG) must fall wholly above the right line, FCD; and by the same method of arguing, the arch, Ch, in the second case, will fall wholly below FCD. Therefore FCD, in both cases, is a tangent to the curve at the point, C; whence the triangles, FmC, and CnS, being similar, it appears that the subtangent, mF, is always a fourth proportional to nS, the fluxion of the ordinate, Cn, the fluxion of the abscis, and Cm, the ordinate; that is, Sn : nG :: mC : mF. Hence, if the abscis, A$m = x$, and the ordinate $mp = y$, we shall have $m\text{F} = \frac{y\dot{x}}{\dot{y}}$; by means of which general expression, and the equation expressing the relation between x and y, the ratio of the fluxions, $\dot{x}$ and $\dot{y}$ will be found, and from thence the length of the sub-tangent, mF, as in the following examples.

1. To draw a right line, CT, a tangent to a given circle, (fig. 12) BCA, in a given point, C. Let CS be perpendicular to the diameter, AB, and put AB $= a$, BS $= x$, and SC $= y$. Then, by the property of the circle, y^2 ($=$ CS^2) $=$ BS $\times$ AS ($= x \times \overline{a - x}$) $= ax - x^2$; whereof the fluxion being taken, in order to determine the ratio of $\dot{x}$ and $\dot{y}$, we get $2y\dot{y} = a\dot{x} - 2x\dot{x}$; consequently $\frac{\dot{x}}{\dot{y}} = \frac{2y}{a - 2x} = \frac{y}{\frac{1}{2}a - x}$; which multiplied by y, gives $\frac{y\dot{x}}{\dot{y}} = \frac{y^2}{\frac{1}{2}a - x} =$ the sub-tangent, ST. Whence, O being supposed the centre, we have OS ($= \frac{1}{2}a - x$) : CS ($= y$) :: CS ($= y$) : ST; which is also found to be the case from other principles.

2. To draw a tangent to any given point, C, (fig. 13) of the conical parabola, ACG. If the *latus rectum* of the curve be denoted by a, the ordinate, MC, by y, and its corresponding abscis, AM, by x; then the known equation, expressing the relation of x and y, being $ax = y^2$, we have, in this case, the fluxion $a\dot{x} = 2y\dot{y}$; whence $\frac{\dot{x}}{\dot{y}} = \frac{2y}{a}$; and consequently, $\frac{y\dot{x}}{\dot{y}} = \frac{2y^2}{a} = \frac{2ax}{a}$, $= 2x =$ MF. Therefore the sub-tangent is just the double of its corresponding abscis, AM. And so for finding the tangents of other species of curves.

TANNING, the art of manufacturing leather from raw hides and skins. Before we detail the process, it may be proper to observe, that raw hides and skins being composed of minute fibres intersecting each other in every direction, the general operation of tanning consists chiefly in expanding

the pores, and dissolving a sort of greasy substance contained in them, and then, by means of the astringency and gummy-resinous properties of oak bark, to fill and reunite them, so as to give firmness and durability to the whole texture. But this theory has been controverted by some chemists, who suppose that the animal jelly contained in the skin is not dissolved, but unites during the process with the astringent principle of the bark, and forms a combination insoluble in water.

The process of tanning varies considerably, not only in different countries, but even in different parts of the same country. The following is the method most approved and practised in London and its vicinity. The leather consists chiefly of three sorts, known by the name of butts or backs, hides, and skins. Butts are generally made from the stoutest and heaviest ox hides, and are managed as follows: After the horns are taken off, the hides are laid smooth in heaps for one or two days in the summer, and for five or six in the winter: they are then hung on poles, in a close room called a smoke-house, in which is kept a smouldering fire of wet tan; this occasions a small degree of putrefaction, by which means the hair is easily got off, by spreading the hide on a sort of wooden horse or beam, and scraping it with a crooked knife. The hair being taken off, the hide is thrown into a pit or pool of water to cleanse it from the dirt, &c. which being done, the hide is again spread on the wooden beam, and the grease, loose flesh, extraneous filth, &c. carefully scrubbed out or taken off; the hides are then put into a pit of strong liquor called ooze or wooze, prepared in pits called letches or taps kept for the purpose, by infusing ground bark in water; this is termed colouring: after which they are removed into another pit called a scowering, which consists of water strongly impregnated with vitriolic acid, or with a vegetable acid prepared from rye or barley. This operation (which is called raising,) by distending the pores of the hides, occasions them more readily to imbibe the ooze, the effect of which is to astringe and condense the fibres, and give firmness to the leather. The hides are then taken out of the scowering, and spread smooth in a pit commonly filled with water, called a binder, with a quantity of ground bark strewed between each.

After lying a month or six weeks, they are taken up; and the decayed bark and liquor being drawn out of the pit, it is filled again with strong ooze, when they are put in as before, with bark between each hide. They now lie two or three months, at the expiration of which the same operation is repeated; they then remain four or five months, when they again undergo the same process; and after being three months in the last pit, are completely tanned, unless the hides are so remarkably stout as to want an additional pit or layer.

The whole process requires from eleven to eighteen months, and some times two years, according to the substance of the hide, and discretion of the tanner. When taken out of the pit to be dried, they are hung on poles; and after being compressed by a steel pin, and beat out smooth by wooden hammers called beetles, the operation is complete; and when thoroughly dry, they are fit for sale. Butts are chiefly used for the soles of stout shoes. The leather which goes under the denomination of hides is generally made from cow hides, or the lighter ox hides, which are thus managed. After the horns are taken off, and the hides washed, they are put into a pit of water saturated with lime, where they remain a few days, when they are taken out, and the hair scraped off on a wooden beam, as before described, they are then washed in a pit or pool of water, and the loose flesh, &c. being taken off, they are removed into a pit of weak ooze, where they are taken up and put down (which is technically termed handling) two or three times a-day for the first week: every second or third day they are shifted into a pit of fresh ooze, somewhat stronger than the former; till at the end of a month or six weeks; they are put into a strong ooze, in which they are handled once or twice a-week with fresh bark for two or three months. They are then removed into another pit, called a layer, in which they are laid smooth, with bark ground very fine, strewed between each hide. After remaining here two or three months, they are generally taken up, when the ooze is drawn out, and the hides put in again with fresh ooze and fresh bark; where after lying two or three months more, they are completely tanned, except a few very stout hides, which may require an extra layer: they are then taken out, hung on poles, and being hammered and smoothed by a steel pin, are, when dry, fit for sale. These hides are called crop

hides; they are from ten to eighteen months in tanning, and are used for the soles of shoes.

Skins is the general term for the skins of calves, seals, hogs, dogs, &c. These, after being washed in water, are put into lime-pits, as before mentioned, where they are taken up and put down every third or fourth day, for a fortnight or three weeks, in order to dilate the pores and dissolve the gelatinous parts of the skin. The hair is then scraped off, and the flesh and excrescences being removed, they are put into a pit of water impregnated with pigeon-dung (called a grainer or mastring,) forming a strong alkaline ley, which in a week or ten day, soaking out the lime, grease, and saponaceous matter (during which period they are several times scraped over with a crooked knife to work out the dirt and filth), softens the skins, and prepares them for the reception of the ooze. They are then put into a pit of weak ooze, in the same manner as the hides, and being frequently handled, are by degrees removed into a stronger and still stronger liquor, for a month or six weeks, when they are put into a very strong ooze, with fresh bark ground very fine, and at the end of two or three months, according to their substance, are sufficiently tanned; when they are taken out, hung on poles, dried, and fit for sale. These skins are afterwards dressed and blacked by the currier; and are used for the upper-leathers of shoes, boots, &c. The lighter sort of hides, called dressing hides, as well as horse-hides, are managed nearly in the same manner as skins; and are used for coach-work, harness-work, &c.

Having given some account of the process as is commonly used in this country, we proceed to one recommended by M. Seguin in France, who is supposed to have done much towards simplifying and rendering perfect the art. In order to give currency to the knowledge which he had obtained by a long course of experiments and actual practice in the business, he exhibited without reserve all that he had discovered, and at the same time actually executed his processes on the large scale, furnishing gratuitously skins and tan, in order that others who were witnesses to his plans might repeat for themselves, and at their leisure, the experiments they had seen him go through. We shall give an outline of his plan and reasoning on this important subject.

Skins swell up, and become soft, by moisture, which renders them permeable to water. Hence they are easily destroyed by the putrid process which ensues, and they become dry and brittle when the moisture is evaporated. Accident, no doubt, occasioned the discovery of the means of preventing these inconveniences by the use of certain vegetable substances, particularly the bark of oak. It was seen that skins prepared with these substances acquired new properties; that without losing their flexibility they became less permeable to water; more firm, more compact, and in some measure incapable of putrefaction. These observations gave birth to the art of the tanner. This art, no doubt of high antiquity, because founded on one of the earliest wants of man in society, comprehends a succession of processes which was executed by habit and imitation, without a knowledge of the essential objects. The preparation of skins accordingly required several years, and frequently, in spite of the care, expense, and slowness of the operation, the tanning, was incomplete; the skin formed a soft and porous leather, which was soon destroyed by moisture. These defects essentially sprung from ignorance of the true principles of this operation, because no discovery had been made respecting the action of tan upon the skin, and the circumstances, or conditions, which might accelerate or retard the process.

To arrive at this knowledge in an accurate manner, it is necessary to consider, first, the nature and properties of tan, and secondly, the structure and composition of the skin. We shall not enter into the detail of such precautions as are requisite in the choice of oak bark, the time and manner of separating it from the tree, preserving it, or pulverising it. It will be sufficient for our object to remark, that water poured into a vessel upon tan acquires, after some hours infusion, at the common temperature of the atmosphere, a brown colour, an astringent taste, and becomes charged with the most soluble substances contained in the tan; that by drawing off the water, and adding a similar quantity to the tan repeatedly, the whole of the soluble parts may be successively extracted, the water ceases to acquire colour, and there remains in the tub a mere fibrous matter, or parenchymatous texture, insoluble in water, and no longer adapted to promote the operation of tanning. This resi-

due is therefore always rejected in the manufactories as useless. It is only used by gardeners for their hot-beds, but might probably be advantageously applied to the fabrication of coarse paper.

It is therefore in the water of infusion, or the lixiviations of tan, that we must seek for the soluble substances which alone are efficacious in tanning. On examination of the water of the last filtration, it is found to be not only clearer, less impregnated and less acrid than the water of the first lixiviation, but likewise that it possesses all the properties of the gallic acid. It reddens the infusion of tournsol, acts upon metallic solutions, and more particularly it precipitates a black fecula from sulphate of iron, &c. And it is also found that a piece of fresh skin, divested of its fat and sanguine humours, and macerated in this liquor, instead of becoming compact, is softened and swells up.

The liquor of the first lixiviation exhibits a very different character. It is more coloured and astringent, it not only exhibits the properties of the gallic acid, by the alterations it causes in the blue colours of vegetables, and the black precipitate it forms with the sulphate of iron, but it likewise possesses the remarkable quality of forming, with animal gelatine, or glue, a yellowish abundant precipitate, insoluble in water, not putrescible, which becomes hard and brittle by drying, and if a piece of skin properly prepared be immersed in this fluid, it becomes gradually more compact, and is converted into leather.

There exist, therefore, in the same fluid, two very different substances: the one, which precipitates a black matter from iron, is the gallic acid or principle, the other, which precipitates animal gelatine or glue, is called the tanning principle, on account of its efficacy in the preparation of leather.

To leave no doubt on this important point, it was proved, by a number of experiments easy to be repeated. 1. That the liquor of the last lixiviation, though coloured, and of an astringent taste, affords no precipitate with glue, a fact, which seems to show that the gallic acid contained in the bark is less soluble than the tanning principle. In fact, as has already been remarked, when water is successively poured on the tan, an infusion is at last obtained which no longer precipitates glue, though it precipitates sulphate of iron very well. 2. The liquor of the first lixiviation, after having been saturated with glue or animal gelatine, and forming an abundant precipitate with that substance, is entirely deprived of the tanning principle. It no longer differs from the liquor of the last filtrations, and contains merely a portion of the gallic acid. Hence the addition of sulphate of iron affords a new precipitate with this liquor. 3. As the tanning principle has a strong attraction to the animal gelatine, with which it always forms an insoluble precipitate, this property affords a very convenient re-agent to ascertain its presence immediately in any fluid, and to determine with precision its quantity. Accordingly, the infusion of tan poured into milk, whey, serum, broth, &c. forms with these liquors, a precipitate more or less abundant, according to the quantity of gelatine they contain.

This peculiar property of the tanning principle affords an application which may become of great importance in the art of treating diseases, to determine the nature of urine, and to ascertain some of its changes. In the healthy subject, all whose functions are duly exercised, the urine does not contain gelatine, nor afford a precipitate with the infusion of tan: on the contrary, in all the gastric affections, the urine is more or less charged with gelatine, and forms, with the infusion of tan, a precipitate more or less abundant. The same observation is applicable to acute and chronical diseases, in which the assimilating or digestive forces are troubled, deranged, or perverted. 4. The gallic acid, or, if other terms be preferred, the principle which precipitates the sulphate of iron, is often found alone, or at least without being accompanied by the tanning principle. Thus, quinquina, crude or torrefied coffee, the roots of the strawberry plant, scrofularia, milfoil, arnica, the flowers of Roman camomile, and all the multitude of plants vaguely comprised under the title of astringents, contain the gallic acid only. All these form with the sulphate of iron a precipitate more or less coloured and abundant, but none of them produce the slightest change in the solution of animal glue. On the contrary, the tanning principle has never been found alone, but always united or combined with the gallic principle. It was long supposed to exist exclusively in the oak, the nut-gall, and sumac, the only substances used at the tan works, but it is found more or less abundantly in the simaquastrum, the rose tree, the larix, several species of pines, the acacias, the lotus, the

squill, the roots of bistort, of rhubarb, of parella, and several other plants. We have also found this principle in the products of distillation of different vegetable substances, where it was in some measure formed during the operation.

From these different considerations, founded on experiment, the following general principles may be deduced: 1. Every substance of which the infusion is capable of precipitating animal jelly, possesses the tanning property. 2. Every substance which possesses the tanning property, likewise precipitates the sulphate of iron black. 3. Every substance which precipitates the sulphate of iron, but not the solution of glue, does not possess the tanning property.

Upon M. Seguin's principle, a patent was some years since taken out by Mr. W. Desmond, who obtains the tanning principle by digesting oak-bark, or other proper material, in cold water, in an apparatus nearly similar to that used in the salt-petre works. That is to say, the water which has remained upon the powdered bark for a certain time, in one vessel, is drawn off by a cock, and poured upon fresh tan. This is again to be drawn off, and poured upon other fresh tan; and in this way the process is to be continued to the fifth vessel. The liquor is then highly coloured, and marks, as Mr. Desmond says, from six to eight degrees on the hydrometer for salts. He calls this the tanning lixivium. The criterion to distinguish its presence is, that it precipitates glue from its aqueous solution, and is also useful to examine how far other vegetable substances, as well as oak-bark, may be suitable to the purpose of tanning. The strong tanning liquor is to be kept by itself. It is found, by trials with the glue, that the tanning principle of the first digester which receives the clear water, is, of course, first exhausted; but the same tan will still give a certain portion of the astringent principle, or gallic lixivium, to water. The presence of this principle is ascertained by its striking a black colour when added to a small quantity of the solution of vitriol of iron, or green copperas. As soon as the water from the digester ceases to exhibit this sign, the tan is exhausted, and must be replaced with new. The gallic lixivium is reserved for the purpose of taking the hair off from hides. Strong hides, after washing, cleaning, and fleshing, in the usual way, are to be immersed for two or three days in a mixture of gallic lixivium, and a thousandth part, by measure, of dense vitriolic acid. By this means the hair is detached from the hides, so that it may be scraped off with a round knife. When swelling or raising is required, the hides are to be immersed for ten or twelve hours in another vat, filled with water, and one five-hundredth part of the same vitriolic acid. The hides being then repeatedly washed and dressed, are ready for tanning; for which purpose they are to be immersed for some hours in a weak tanning lixivium, of only one or two degrees; to obtain which, the latter portions of the infusions are set apart, or else some of that which has been partly exhausted by use in tanning. The hides are then to be put into a stronger lixivium, where, in a few days, they will be brought to the same degree of saturation with the liquor in which they are immersed. The strength of the liquor will by this means be considerably diminished, and must therefore be renewed. When the hides are by this means completely saturated, that is to say, perfectly tanned, they are to be removed, and slowly dried in the shade. Calf-skins, goat-skins, and the like, are to be steeped in lime-water, after the usual fleshing and washing. These are to remain in the lime-water, which contains more lime than it can dissolve, and requires to be stirred several times a-day. After two or three days, the skins are to be removed, and perfectly cleared of their lime by washing and pressing in water. The tanning process is then to be accomplished in the same manner as for the strong hides; but the lixivium must be considerably weaker. Mr. Desmond remarks, that lime is used instead of the gallic lixivium for such hides as are required to have a close grain; because, the acid mixed with that lixivium always swells the skins more or less: but that it cannot, with the same convenience, be used with thick skins, on account of the considerable labour required to clear them of the lime; any part of which, if left, would render them harsh, and liable to crack. He recommends, likewise, as the best method to bring the whole surface of the hides in contact with the lixivium, that they should be suspended vertically in the fluid, by means of transverse rods or bars, at such a distance as not to touch each other. By this practice, much of the labour of turning and handling may be saved. Mr. Desmond concludes his specification by observing, that in some cases it will be expedient to mix fresh tan with the lixivium; and that

various modifications of strength, and other circumstances, will present themselves to the operator. He affirms that, in addition to the great saving of time and labour in this method, the leather, being more completely tanned, will weigh heavier, wear better, and be less susceptible of moisture, than leather tanned in the usual way; that cords, ropes, and cables, made of hemp or speartery, impregnated with the tanning principle, will support much greater weights without breaking, be less liable to be worn out by friction, and will run more smoothly on pullies, insomuch that, in his opinion, it will render the use of tar in many cases, particularly in the rigging of ships, unnecessary; and, lastly, that it may be substituted for the preservation of animal food instead of salt. The intelligent manufacturer will readily perceive, that this new method is grounded on two particular circumstances, besides a more scientific management of the general process than has been usual. The first consists in the method of determining the presence and quantity of the tanning principle, by the hydrometer, and the precipitation of glue: the second, in applying this principle, in a concentrated state, more early in point of time than has, perhaps, been hitherto done. Our tanners, after the common previous processes, and unhairing by acids, by lime, or by piling the hides that they may heat and begin to putrify, apply the solution of tan, which they call ouze, in a great number of pits in the tan yard. They begin with the weakest solution, which has been used, and is of a lighter colour than the other, and they pass the hides, according to their judgment and experience, into ouzes which are stronger and stronger, until at last, in certain cases, the hides come to be buried, for a certain time, in a solid mass of tan, or oak-bark. The oak-bark itself, in the pits, is not only the source from which the water extracts the tanning principle, but seems, likewise, in some measure, during the last stages of the process, to operate mechanically, by keeping the surfaces of the hides from touching each other.

TANTALITE, in mineralogy, a metallic fossil of an iron black colour on the external surface, but internally between bluish-grey, and iron-black. It occurs imbedded, in masses of the size of a hazel nut, which have a tendency to the octahedral form. Externally it is smooth and glimmering; internally it is shining, and its lustre metallic. Specific gravity is 7.95. Its constituent parts are tantalium, iron, and manganese. It is found imbedded in quartz, in Sweden; its name is derived from the new metal denominated TANTALIUM, which see.

TANTALIUM, a metal discovered by M. Ekeberg, in the mineral just mentioned; and in another named Yttrotantalite. From each he extracted by means of the fixed alkalies a white powder, which he ascertained to be the oxide of a peculiar metal; to this he gave the name of tantalium. When this oxide is powerfully heated with charcoal, it yields a button moderately hard, which, externally, has a metallic lustre, but internally it is black, and without any degree of brilliancy. The acids will reduce it again to an oxide, but they will not dissolve it. It melts before the blow-pipe with borax, or phosphate of soda, but gives no colour to either of them. Its specific gravity is about 6.5.

TANTALUS, the *ibis*, in natural history, a genus of birds of the order Grallæ. Generic character: bill long; thick at the base, incurvated; face naked, and sometimes all the head; tongue broad and short; nostrils linear and oval; four toes, connected by a membrane at the base. There are nineteen species, of which we shall notice the following. T. loculator, the wood ibis, is of the size of a goose, and the length of three feet, and is found in Carolina, and in many countries of South America, haunting, particularly, those low tracts which are inundated during summer. These birds subsist on reptiles and fish, have little sagacity, and are often seen in cypress trees of extraordinary height, with their heavy bills reposing on their breasts. They are in use for the table, though far from being excellent.

T. ruber, or the scarlet ibis, is found in America, and the neighbouring islands. Its plumage is of a most ardent scarlet, and it is one of the most beautiful birds of the genus. It subsists on insects, and the ova of fishes, for which, on the ebbing of the tide, it frequents the shores. It perches in trees, but lays its eggs on the ground. The old birds and the young keep in distinct flocks. They do not attain the full lustre and glow of plumage till their third year; and in sickness and confinement lose almost all their brilliancy.

T. ibis, or the Egyptian ibis, is more than three feet long, and as large as a stork. On the retreating of the Nile, it is found in Lower Egypt in great numbers, subsisting on insects and frogs. It perches

on palm trees, and sleeps in an erect attitude, its tail touching its legs. It is supposed by some naturalists to be the ibis of the ancients, and is known to destroy and devour serpents. Others suppose it to be the ox-bird described by Shaw. For the blackheaded ibis, see Aves, Plate XIV. fig. 2.

TANTALUS's *cup*, in hydraulics, a siphon so adapted to a cup, that the short leg being in the cup, the long leg may go down through the bottom of it.

The bended siphon is called Tantalus's cup, from the resemblance of the experiment made with an image in the glass, representing Tantalus in the fable, fixed up in the middle of the cup with a siphon concealed in his body, beginning in the bottom of his feet, and ascending to the upper part of his breast, there it makes a turn, and descends through the other leg, on which he stands; and from thence down through the bottom of the cup, where it runs out, and causes the water to subside in the cup; as soon as it rises to the height of the siphon, or to the chin of the image, the water will begin to run through the siphon concealed in the figure, till the cup is emptied in the manner explained under siphon, and represented more distinctly in the article HYDRAULICS.

TAPE *worm*. See TÆNIA.

TAPESTRY. It has been supposed that the use of tapestry was introduced into the various nations of Europe from the Levant, by the princes and nobles who commanded in the different crusades, undertaken to recover the Holy Land from the Saracens; but this supposition seems in a great measure to rest on the fact, that the workmen employed in this pursuit in France were called Sarrassinois. We do not find, upon referring to the travels of Bertrandon de la Brocquiere to Palestine, in 1432, any thing to support the assertion, neither do our modern tourists mention tapestry as used by the present inhabitants of that country. Lempriere describes the apartments of the Harem at Morocco to have been hung with rich damasks; but as the same rooms had European mirrors on the walls, it does not appear quite clear that the hangings were not introduced by the same means.

There is not a doubt that the Greeks used tapestry, as Homer frequently mentions the labours of the loom in a manner that proves the production of it could have been employed in no other way. Those countries which are subject to long and cold winters, made it necessary that the rich and powerful should adopt some method to check its disagreeable effects on domestic comfort, and besides the feudal system universally prevailing, their residences were calculated for military purposes only, and every consideration of internal convenience was sacrificed to the means of defence from their jealous and envious neighbours of the same rank in the state; hence they constructed their mansions with walls as solid and impenetrable as those of a fortified city, in which the windows were little better than loop-holes for missive weapons externally, whence they were widened inwards to make the most of the little light and air they were capable of admitting.

Cold and dreary as all their apartments were, every possible contrivance was made to temper the damp chill of the walls; for this purpose vast fire places were constructed, occupying almost one side of the square, and hangings were suspended to exclude from view the rough surface of the massy stones, and to confine the humidity in them from immediately attaching to the family. That which may have been used in Greece, in Palestine, and throughout Asia, for the double purposes of ornament, and for the convenience of easy removal during the warmth prevailing in those countries where tapestry or hangings make the most pleasant partitions or separations of apartments, became necessary in the greatest part of Europe through a directly opposite cause.

Whatever was the nature of the original hangings in our quarter of the globe, and wherever they were introduced from, it is very certain that the French have had the honour of giving them their present denomination, which is derived from tapisser, to line, and that from the Latin tapes. It is very probable that the tapestry of ancient times in England, and on the Continent, was equally rude and barbarous with the paintings of the same period, and perhaps more so, and in the present state of the country it is difficult to ascertain when it improved or when attempts were made to introduce figures in the weaving of it. When the feudal system ceased, our castles and castellated mansions were gradually deserted, and their possessors mixing more with the general population, began to admire the comforts of society, and to adopt some of the customs of those they had hi-

therto despised; hence occurred a new mode of building, which, though it in some degree resembled that of their ancestors, was attended with infinite improvement. It is in the residences thus produced that we are now to look for the tapestry once so necessary, but in the latter instance preserved through a laudable family pride, and as objects of curiosity. At Hardwicke Hall in Derbyshire, one of the seats of the Duke of Devonshire, built by a Countess of Shrewsbury, in the reign of Queen Elizabeth, some very interesting tapestry and hangings of a bed are shown, which were worked by Mary, Queen of France and Scotland, during her long confinement at that place, previously to her execution. As may be anticipated from her mode of faith, and the circumstances of her situation, the colours and subjects are of a sombre and melancholy cast, but sufficiently well done to excite approbation.

Those it will be remembered are the product of the needle, and are therefore very different from that which adorns the walls of the House of Lords from the loom, and are nearly coeval with the performances of the royal captive, the latter have long been celebrated as the only representations we possess of the destruction of the Spanish Armada, but their age and the fading of their colours have greatly lessened their interest. Exclusive of those there are specimens of ancient tapestry at the Charter House, placed there by the Duke of Norfolk in the reign of Elizabeth, and at St. James's Palace, which is the best in every particular of all that has been mentioned.

It will be perceived, that in each of these instances the dates nearly correspond, whence it may be safely concluded, that very little use was made of tapestry after the reign of James I in England. Next to the English, the Flemings were most expert at weaving of rich hangings, the French who subsequently exceeded all other nations in this art, did not apply themselves to it till the reign of their Henry IV. when an establishment was made in the year 1607 in the Fauxbourg St. Michael at Paris, after the assassination of that monarch, the manufactory was neglected, nor was it revived till the reign of Louis XIV under the auspices of Colbert, who caused a receptacle for this work to be constructed, where two brothers named Giles and John Gobelins, had long before been celebrated as excellent dyers, whence the name, which an edict issued by Louis, confirmed under the title of Hotel Royal des Gobelins. As it was the intention of the luxurious monarch just mentioned to excel all his contemporary sovereigns of Europe in the splendour of his palaces and establishments, the manufactory of the Gobelins was placed by him under a complete system of government, and it flourished with some fluctuations of neglect and encouragement as a royal institution, till the late revolution, during which dreadful period it was consigned, to all appearance, to irretrievable ruin; but the subsequent consulship of Bonaparte, and his further elevation to the throne of France, has in a great degree recovered it, though the change in public opinion in the manner of decorating walls will prevent it from obtaining its pristine encouragement.

The reader will forgive our enlarging on this subject, as the Gobelins is the only manufactory of tapestry remaining in Europe worthy of particular notice, and where paintings are imitated with all the strength and beauty of colouring of the pictures from which they are copied. M. Le Maistre, who visited Paris in 1802, mentions two pieces made about that time, one representing the assassination of Admiral Coligni, and the other the heroic conduct of the President Molé, of uncommon excellence. Ninety persons were then employed, and appeared to work with the utmost ease, though six years apprenticeship and much attention and care are required to attain superior skill. Previously to the change in the government of France, the workmen were in a great degree state prisoners, but such is the jealousy of rivalship, that they are still under the special care or surveillance of the police, and the pieces manufactured were destined principally to ornament the favourite residence of St. Cloud, and some other public buildings. To this information we shall subjoin the still more recent account of Mr. Pinkerton in 1805. "In the ancient method," says that gentleman, "the workmen were obliged to stoop, which was found detrimental to their health, and the pictures were destroyed, being cut in pieces in the width of the loom, the figures were also reversed. Neilson, an intelligent foreman, contrived to save the pictures, in tracing them with oil-paper. Nor were the figures reversed as before, and the picture itself was placed behind the workman, that he might accurately express the shades and tone of colour. Still the result could not be judged

of, till each division was perfected in the loom. Vaucanson superadded an easy and ingenious mechanism, to examine with pleasure the progress of the work; but the manufacture continued to be guided by a servile routine."

The last director introduced three improvements, which cannot very well be explained, but the result has been of great advantage in the manner of weaving, and as more judgment has been evinced in the selection of pictures for copying, the style of colouring partakes more of the taste of each master than when it was the custom to make all the tints vivid and gaudy; besides, as they have ceased to use silk, the tapestry is much less subject to fade. "Yet," adds Mr. Pinkerton, "the colours are sufficiently bright and various to represent, with exquisite truth, all the fine tints of beautiful flowers. It is however to be regretted that these splendid tapestries become so expensive, from the length of time required in the workmanship, that even the rich tremble; and the sale to the government, which presents them to distinguished foreigners, affords the chief if not sole consumption. The sum annually allowed, to support the manufacture in its greatest activity, is estimated at one hundred and fifty thousand francs."

As it is not in our power to obtain the precise improvements made in the manner of weaving tapestry, we are compelled to describe the mode by which that now remaining in England was made, and which is undoubtedly the basis of the present method in use at the Gobelins. The loom employed for this purpose stands perpendicularly, and is composed of four principal pieces, two of which are long planks, and the others rollers or beams of considerable diameter; the planks are placed upright, and the beams cross them at either extremity of the loom, the lower at about twelve inches from the floor, each have trunnions which suspend them on the planks, and they are turned with bars. The rollers are grooved lengthways, in which are fastened long cylinders of wood with hooks; the use of these is to fasten the ends of the warp to, the latter of twisted woollen thread encircles the upper roller, and it is worked as fast as wove on the lower.

The planks already mentioned are seven or eight feet in height, from fourteen to fifteen inches broad, and three or more in thickness; their interior surfaces are pierced into holes the whole length, for the admission of thick pieces of iron with hooks at their ends, which are intended to support what is called the coat-stave; those irons are also pierced to receive pins, by which the stave is contracted or expanded at pleasure. The coat-stave, three inches in diameter, extends the whole length of the loom, and on it are fixed the coats or threads, and thus the threads to the warp cross each other, in this particular having nearly the same effect with the spring-stave and treddles in the common looms. The coats, as they are called, are threads fastened to each thread of the warp by a sliding knot; those keep the warp open, and thus the broaches bearing the material for weaving are passed freely through, according to the will of the workman; besides the process is further facilitated by small pieces of wood, which are used to make the thread of the warp intersect each other, and that those may keep their due situation, a packthread is run among the threads above the stick.

We will now suppose the loom prepared with the warp, the operator then proceeds to sketch the principal outline on the threads composing it from the picture or design to be copied, and this is done by placing the painting, or a cartoon, on the back of the intended tapestry, and tracing it with a black-lead pencil; after accomplishing the transfer, the original is rolled on a cylinder, and placed behind the workman, who unrolls it in the same progression with which he weaves. Exclusive of the instruments already mentioned, a broach, a reed, and an iron needle, are required for introducing the silk or wool of the woof amongst the threads of the warp; the first is about two-thirds of an inch thick, and seven or eight inches in length, terminating at one extremity in a point with the other, formed into a kind of handle, and is made of hard wood; this broach, as it is termed, serves as a shuttle, the silk, wool, gold, or silver thread being wound on it. The reed is a kind of comb, made of wood, eight or more inches in length, and an inch thick at the back, tapering thence to the teeth, which vary in their distance from each other, according to the fineness of the tapestry. The needle varies from the common instrument of that name only in its size, and its use is to press the material close in those parts where any defect is observed. The most singular part of the weaving of tapestry is the position of the weaver who works on the wrong side of the piece, and with his back to the picture he is to imitate,

consequently he is frequently compelled to leave his position and pass to the opposite side of the loom, to ascertain whether he has been correct in his proceedings. When he is about to put the material in the warp, he turns and examines the original; then having furnished the broach with the colour required, he introduces it amongst the threads of the warp, which he brings across each other with his fingers, through the assistance of the coats or threads secured to the staff, and this operation is repeated with every change of tint. After the wool or silk is placed, he presses it close with the reed or comb, and examining the picture, he makes the necessary amendments with the needle. Those subjects which are very large may be worked upon by more than one weaver at a time. The method we have described is called the high warp, another, the low warp, though rather different in the manner of weaving it, so nearly resembles the tapestry of the high warp that it is unnecessasy to describe it.

TAPIR, in natural history, a genus of Mammalia of the order Belluæ. Generic character: ten fore teeth in each jaw; tusks in both jaws single and incurvated; five grinders on each side in both jaws; feet with three hoofs, and on the fore feet a false hoof. The only species is the T. Americanus. This is a native of South America, and when perfect in growth is about the size of a heifer. Its colour is a dark brown, and the male is distinguished by a species of very short proboscis. The tapir is perfectly inoffensive, and considerably timid, seeking safety in flight, and often plunging into waters, in which he swims with great rapidity, and in which sometimes he proceeds for a long way, ranging at the bottom at a very great depth; in this respect resembling the hippopotamus. When resting, the tapir sits in the manner of a dog. In feeding, its trunk is employed in drawing into its mouth the vegetables which constitute its nourishment. In some parts of Guiana it has been domesticated, and, when taken young, is easily familiarized. Its flesh is not excellent for flavour or delicacy, but is nevertheless used for food; and its skin, which is of uncommon toughness, is converted to various purposes of usefulness. It is slow in its movements, sleeps during the greater part of the day, and is destroyed by the Indians, who decoy it by the imitation of its peculiar sounds, by poisoned arrows. It produces but one at a birth, in the care of which it is extremely assiduous and affectionate.

TAR, a thick, black, unctuous substance, obtained from old pines and fir trees, by burning them with a close smothering heat: it is used for coating and caulking ships, &c. and various other purposes.

TARANTULA. See ARANEA.

TARCHONANTHUS, in botany, African *flea-bane*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Nucamentaceæ. Corymbiferæ, Jussieu. Essential character: calyx one-leafed, commonly half seven-cleft, turbinate; seeds covered with down; receptacle villose. There are three species: these plants are all natives of the Cape of Good Hope.

TARE, is an allowance for the outside package, that contains such goods as cannot be unpacked without detriment, or for the papers, threads, bands, &c. that inclose or bind any goods imported loose; or, though imported in casks, chests, &c. yet cannot be unpacked and weighed net. Several sorts of goods have their tares ascertained, and those are not to be altered or deviated from, in any case, within the port of London, unless the merchant thinking himself, or the officers of the crown, to be prejudiced by such tares, shall desire that the goods may be unpacked, and the net-weight taken; which may be done either by weighing the goods in each respective cask, &c. net, or (as is practised in East India goods particularly) by picking out several casks, &c. of each size, and making an average, compute the rest accordingly. But this must not be done without the consent of two surveyors, attested by their hands in the landwaiter's books; and in the out-ports, not without the consent of the collector and surveyor. And as to those goods which have not their tares ascertained, two surveyors in London, and the collector and surveyor in the outports, are to adjust and allow the same, in like manner. Sometimes the casks, &c. are weighed beyond sea, before the goods are put in; and the weight of each respective cask, &c. marked thereon (as is usual for most goods imported from the British plantations), or else inserted in the merchant's invoice; in which case, if the real invoice be produced, and the officers have satisfied themselves (by unpacking and weighing some of them) that those weights are just and true, they do then, after having reduced them to British weight, esteem them to be

the real tares, and pass them accordingly. But the unpacking goods, and taking the net weight, being supposed the justest method, both for the crown and merchant, it is usually practised in the port of London, in all cases where it can be done with conveniency, and without detriment to the goods.

TARGIONIA, in botany, so named in honour of Cypriani Targioni, M. D. of Florence, a genus of the Cryptogamia Hepaticæ. Generic character: calyx two-valved, compressed, containing at bottom a capsule nearly globular, many-seeded. There is only one species; viz. T. hypophylla, a native of Italy, Spain, Constantinople, Flanders, Saxony, about Dresden; and England, near Dawlish, in Devonshire; flowering from March to May.

TARTARIC *acid*, in chemistry, was procured by Scheele in a separate state in the year 1770. The process which he followed was by boiling a quantity of the substance called tartar, or cream of tartar, in water, and adding powdered chalk till effervescence ceased, and the liquid no longer reddened vegetable blues. It was then allowed to cool; the liquor filtered; and a white insoluble powder remained on the filter, which was carefully removed and well washed. This was put into a matrass, and a quantity of sulphuric acid, equal in weight to the chalk employed, diluted with water, poured upon it. The mixture was allowed to digest for twelve hours on a sand bath, stirring it occasionally with a glass rod. The sulphuric acid combined with the lime, and formed a sulphate of lime, which fell to the bottom. The liquid contained the tartaric acid dissolved in it. This was decanted off, and a little acetate of lead dropped into it, as a test to detect the sulphuric acid, should any remain, and if this be the case, it must be digested again with more tartrate of lime, to carry off what remains of the sulphuric acid. It is then to be evaporated, and about one-third of the weight of the tartar employed is obtained of concrete tartaric acid. To purify this, the crystals may be dissolved in distilled water, and again evaporated and crystallized. It seems probable that this acid exists in a state of purity in some vegetables. Vauquelin found a 64th part in the pulp of the tamarind. Tartaric (or tartarous) acid thus obtained is in the form of very fine needle shaped crystals; but they have been differently described by different chemists. According to Bergmen, they are in the form of small plates, attached by one extremity, and diverging at the other. They have been found by others grouped together in the shape of needles, pyramids, regular six-sided prisms, and square and small rhomboidal plates. The specific gravity is 1.6. This acid has a very sharp, pungent taste; diluted with water, it resembles the taste of lemon juice; and it reddens strongly blue vegetable colours. When it is exposed to heat, on burning coals, it melts, blackens, emits fumes, froths up, and exhales a sharp pungent vapour. It then burns with a blue flame, and leaves behind a spongy mass of charcoal, in which some traces of lime have been detected. In the decomposition of the tartaric acid by heat, one of the most remarkable products which particularly characterizes it, is an acid liquor of a reddish colour, which amounts to one-fourth of the weight of the former. This was formerly known by the name of pyrotartarous acid. It has a slightly acid taste, produces a disagreeable sensation on the tongue, is strongly empyreumatic, and reddens the tincture of turnsole. But it has been found by the experiments of Fourcroy and Vauquelin to be the acetic acid impregnated with an oil. Tartaric acid is very soluble in water. The specific gravity of a solution formed by Bergman, was found to be 1.2. This solution in water is not liable to spontaneous decomposition, unless it is diluted. While it is concentrated, it loses nothing of its acid nature or its other properties. According to the analysis of Fourcroy and Vauquelin, 100 parts of this acid are composed of

Oxygen	70.5
Carbon	19.0
Hydrogen	10.5
	100.0

Tartaric acid is not applied to any use, and but few of its combinations are employed in the practice of medicine.

TASTE, *sense of*. The senses of taste and smell are nearly allied to the sense of feeling; indeed they may be considered as modifications of feeling. They however are properly distinguished from it, because they have each a peculiar organ, and are each affected by peculiar properties of bodies. The chief organ of taste is the tongue; and it is fitted for its office by the numerous extremities of nerves which are lodged

along its surface, and particularly at the top and sides. Hartley considers this sense as extending to the other parts of the mouth, down the throat, the stomach, and the other parts of the channel for food. Taken in this comprehensive sense, the sense of taste conveys to the mind sensations not only of flavours, but of hunger and thirst.

In order to produce the sense of taste, the nervous extremities of the tongue must be moistened, and the action of eating generally produces an effusion of a fluid from different parts of the mouth, which answers the purpose of exciting the taste and of assisting digestion. The pleasures derived from taste are very considerable; and the power of yielding pleasurable sensations accompanies the taste through the whole of life. Hence it is reasonable to infer that the pleasures of taste constitute one grand source of the mental pleasures, that is, those which can be felt without the direct intervention of sensation. They leave their relicts in the mind; and these combine together, with other pleasures, and thus form feelings which often connect themselves with objects which have no immediate connection with the objects of taste. To this source Hartley traces the principal origin of the social pleasures; and there cannot be a doubt that the pleasures of taste are the chief original sources of the filial affection. It appears that one end of the long continuance of the pleasures of taste is to supply continual accessions of vividness to the mental pleasures; but doubtless, the principal object is to make that a source of pleasure, which is necessary for self-preservation. The pains of taste are much less numerous than those of feeling. They are only such as are necessary to prompt to avoid excessive abstinence or gratification, and to prevent the employment of improper food; and therefore depend much more upon causes which man usually has under his own controul.

TAUGHT, a term used in maritime business, to denote the state of being extended, or stretched out, and is usually applied in opposition to slack.

TAURUS, the *bull*, in zoology. See Bos.

TAURUS, in astronomy, one of the twelve signs of the zodiac, the second in order, consisting of forty-four stars, according to Ptolemy; of forty-one, according to Tycho; and of no less than one hundred and thirty-five, according to the Britannic catalogue.

TAWING, the art of dressing skins in white, so as to be fit for divers manufactures, particularly gloves, &c. All skins may be tawed; but those chiefly used for this purpose are lambs, sheep, kids, and goat-skins.

TAXUS, in botany, *yew-tree*, a genus of the Dioecia Monadelphia class and order. Natural order of Coniferæ. Essential character: male calyx none; corolla none; stamina many; anthers peltate, eight-cleft; female corolla none; style none; seed one, in a berried calycle that is quite entire. There are four species, we shall notice the T. baccata, common yew-tree, which has a straight trunk, with a smooth, deciduous bark; the wood is hard, tough, and of a fine grain; leaves thickly set, linear, smooth, ever-green; flowers axillary, enveloped with imbricate bractes; the male on one tree, sulphur-coloured, without a calyx; the female on another, with a small green calyx, sustaining the oval flattish seed, which calyx at length becomes red, soft, full of a sweet slimy pulp. The yew-tree is a native of Europe, North America, and Japan; its proper situation is in mountainous woods, or more particularly the clefts of high calcareous rocks. England formerly possessed great abundance, and it is now not very uncommon, in a wild state, in some parts of the country. Of planted trees there are yet several in church-yards. Mr. Evelyn mentions a yew-tree in the church-yard of Crowhurst, in Surrey, which was ten yards in compass; another in Braburne church-yard, not far from Scot's Hall, in Kent, being fifty-eight feet, eleven inches, in circumference, or nearly twenty feet in diameter.

TEARS, a name for the limpid fluid secreted by the lachrymal glands, and flowing on the surface of the eye; either in consequence of local irritation, or the emotions of grief. Some part of this aqueous fluid is dissipated in the air; but the greatest part, after having performed its office, is propelled by the orbicular muscle, which so closely constringes the eye-lid to the ball of the eye as to leave no space between, unless in the internal angle, where the tears are collected.

From this collection the tears are absorbed by the orifices of the punctæ lachrymaliæ; from thence they are propelled through the lachrymal canals into the lachrymal sac, and flow through the ductus nasalis into the cavity of the nostrils, under the inferior concha nasalis. The tears have no smell, but a saltish taste. The uses of the

tears are these: 1. They continually moisten the surface of the eye and eye-lids, to prevent the transparent cornea from drying and becoming opaque, or the eye from concreting with the eye-lids. 2. They prevent that pain which would otherwise arise from the friction of the eye-lids against the ball of the eye from continually winking. 3. They wash away dust, or any thing acrid, that may have fallen into the eye. This liquid is transparent and colourless, has no perceptible smell, but a saline taste. It communicates to vegetable blues a permanent green colour. When it is evaporated nearly to dryness, cubic crystals are formed, which are muriate of soda. Soda is in excess, because vegetable blues are converted by it to a green colour. A portion of mucilaginous matter, which becomes yellow as it dries, remains after the evaporation. This liquid is soluble in water, and in alkalies. Alcohol produces a white flaky precipitate, and when it is evaporated, muriate of soda and soda remain behind. By burning the residuum, some traces of phosphate of lime and of soda are detected. The component parts of tears are therefore,

Water,	Muriate of soda,
Mucilage,	Phosphate of lime,
Soda,	Phosphate of soda.

The mucilage of tears absorbs oxygen from the atmosphere, and becomes thick, viscid, and of a yellow colour. It is then insoluble in water. Oxymuriatic acid produces a similar effect. It is converted into muriatic acid, so that it has been deprived of its oxygen. The mucus of the nose consists of the same substances as the tears; but being more exposed to the air, it acquires a greater degree of viscidity from the mucilage absorbing oxygen.

TECHNICAL expresses somewhat relating to arts or sciences: in this sense we say technical terms. It is also particularly applied to a kind of verses wherein are contained the rules or precepts of any art, thus digested to help the memory to retain them, an example whereof may be seen in the article MEMORY.

TECTONA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Vitices, Jussieu. Essential character: corolla five-cleft, stigma toothed; drupe dry, spongy, within the inflated calyx, nut three-celled. There is only one species, viz. T. grandis, teak wood, or Indian oak; the trunk of this tree grows to an immense size; bark ash-coloured, branches cross-armed, numerous, spreading; young shoots four-sided; leaves opposite, above scabrous, beneath covered with soft white down, the leaves on young trees from twelve to twenty-four inches long, and from eight to sixteen broad; petiole short, thick, laterally compressed, panicle terminating, very large, cross-armed, divisions dichotomous, with a sessile fertile flower in each cleft the whole covered with a hoary farinaceous substance, flowers small, white, very numerous, fragrant; nectary very small; nut exceedingly hard, four-celled. It is a native of the large forests in Java and Ceylon, Malabar, Coromandel, Pegu, Ava, the confines of Cochinchina, and Cambodia, &c. The wood of this tree has by long experience been found to be the most useful timber in Asia, it is light, easily worked, and at the same time both strong and durable: for ship building the teak is reckoned superior to any other sort of wood. A durable vessel of burthen cannot be built in the river of Bengal, without the aid of teak plank, some of the finest merchant ships ever seen on the river Thames have arrived from Calcutta, where they were built of teak timber.

TEETH. See ANATOMY. Teeth have been analyzed by Mr. Pepys, who has found the constituent parts of teeth of different ages to be, in different proportions: phosphate of lime, carbonate of lime, and cartilage.

According to Fourcroy and Vauquelin, the enamel is composed of

Phosphate of lime..............	72.9
Gelatine and water............	27.1
	100

TELEGRAPH, a word derived from the Greek, and which is very properly given to an instrument, by means of which information may be almost instantaneously conveyed to a considerable distance. The telegraph, though it has been generally known and used by the moderns only for a few years, is by no means a modern invention. There is reason to believe that amongst the Greeks there was some sort of telegraph in use. The burning of Troy was certainly known in Greece very soon after it happened, and before any person had returned from thence. Now that was altogether so tedious a piece of business, that conjecture never could have supplied the place of information. A Greek play begins with a scene in which a watchman descends from the top of a tower in Greece, and

gives the information that Troy was taken. "I have been looking out these ten years (says he) to see when that would happen, and this night it is done." Of the antiquity of a mode of conveying intelligence quickly to a great distance, this is certainly a proof. The Chinese, when they send couriers on the great canal, or when any great man travels there, make signals, by fire, from one day's journey to another, to have every thing prepared; and most of the barbarous nations used formerly to give the alarm of war by fires lighted on the hills or rising grounds.

It does not appear that the moderns had thought of such a machine as a telegraph till the year 1663, when the Marquis of Worcester, in his "Century of Inventions," affirmed that he had discovered "a method by which, at a window, as far as eye can discover black from white, a man may hold discourse with his correspondent, without noise made or notice taken; being according to occasion given, or means afforded, *ex re nata*, and no need of provision before hand; though much better if foreseen, and course taken by mutual consent of parties." This could be done only by means of a telegraph, which in the next sentence is declared to have been rendered so perfect, that by means of it the correspondence could be carried on "by night as well as by day, though as dark as pitch is black."

About forty years afterwards M. Amontons proposed a new telegraph. His method was this: Let there be people placed in several stations, at such a distance from one another, that by the help of a telescope a man in one station may see a signal made in the next before him; he must immediately make the same signal, that it may be seen by persons in the station next after him, who are to communicate it to those in the following station, and so on. These signals may be as letters of the alphabet, or as a cypher, understood only by the two persons who are in the distant places, and not by those who make the signals. The person in the second station making the signal to the person in the third the very moment he sees it in the first; the news may be carried to the greatest distance in as little time as is necessary to make the signals in the first station. The distance of the several stations, which must be as few as possible, is measured by the reach of a telescope. Amontons tried this method in a small tract of land, before several persons of the highest rank, at the court of France. It was not, however, till the French revolution that the telegraph was applied to useful purposes.

Whether M. Chappe, who is said to have invented the telegraph first used by the French about the end of 1793, knew any thing of Amonton's invention or not, it is impossible to say; but his telegraph was constructed on principles nearly similar. The manner of using this telegraph was as follows: At the first station, which was on the roof of the palace of the Louvre at Paris, M. Chappe, the inventor, received in writing from the Committee of Public Welfare, the words to be sent to Lisle, near which the French army at that time was. An upright post was erected on the Louvre, at the top of which were two transverse arms, moveable in all directions by a single piece of mechanism, and with inconceivable rapidity. He invented a number of positions for these arms, which stood as signs for the letters of the alphabet; and these, for the greater celerity and simplicity, he reduced in number as much as possible. The grammarian will easily conceive that sixteen signs may amply supply all the letters of the alphabet, since some letters may be omitted not only without detriment but with advantage. These signs, as they were arbitrary, could be changed every week; so that the sign of B for one day, might be the sign of M the next; and it was only necessary that the persons at the extremities should know the key. The intermediate operators were only instructed generally in these sixteen signals; which were so distinct, so marked, so different the one from the other, that they were easily remembered.

The construction of the machine was such, that each signal was uniformly given in precisely the same manner at all times: It did not depend on the operator's manual skill; and the position of the arm could never, for any one signal, be a degree higher or a degree lower, its movement being regulated mechanically. M. Chappe having received at the Louvre the sentence to be conveyed, gave a known signal to the second station, which was Mont Martre, to prepare. At each station there was a watch tower, where telescopes were fixed, and the person on watch gave the signal of preparation which he had received, and this communicated successively through all the line, which brought them all into a state of readiness. The person at Mont Martre then received, letter by letter, the sentence

from the Louvre, which he repeated with his own machine; and this was again repeated from the next height, with inconceivable rapidity, to the final station at Lisle.

Various experiments were in consequence tried upon telegraphs in this country; and one was soon after set up by government, in a chain of stations from the Admiralty office to the sea-coast. It consists of six octagon boards, each of which is poised upon an axis in a frame, in such a manner that it can be either placed vertically, so as to appear with its full size to the observer at the nearest station, or it becomes invisible to him by being placed horizontally, so that the narrow edge alone is exposed, which narrow edge is from a distance invisible. Six boards make thirty-six changes, by the most plain and simple mode of working; and they will make many more if more were necessary: but as the real superiority of the telegraph over all other modes of making signals consists in its making letters, we do not think that more changes than the letters of the alphabet, and the arithmetical figures, are necessary; but, on the contrary, that those who work the telegraphs should avoid communicating by words or signs agreed upon to express sentences; for that is the sure method never to become expert at sending unexpected intelligence accurately. This telegraph is, without doubt, made up of the best number of combinations possible; five boards would be insufficient, and seven would be useless. It has been objected to it, however, that its form is too clumsy to admit of its being raised to any considerable height above the building on which it stands; and that it cannot be made to change its direction, and consequently cannot be seen but from one particular point. Several other telegraphs have been proposed to remedy these defects, and perhaps others to which the instrument is still liable. The dial-plate of a clock would make an excellent telegraph, as it might exhibit one hundred and forty-four signs, so as to be visible at a great distance. A telegraph on this principle, with only six divisions instead of twelve, would be simple and cheap, and might be raised twenty or thirty feet high above the building without any difficulty: it might be supported on one post, and therefore turn round; and the contrast of colours would always be the same.

TELESCOPE, an optical instrument, which is used for discovering and viewing distant objects, either directly by glasses, or by reflection. Telescopes are either refracting or reflecting; the former consist of different lenses, through which the objects are seen by rays refracted by them to the eye; and the latter, of specula, from which the rays are reflected and passed to the eye. The lens, or glass, turned to the object, is called the object-glass; and that next the eye, the eye-glass; and when the telescope consists of more than two lenses, all but that next the object are called eye-glasses.

The principal effects of telescopes depend upon this maxim, "that objects appear larger in proportion to the angles which they subtend at the eye; and the effect is the same, whether the pencils of rays, by which objects are visible to us, come directly from the objects themselves, or from any place nearer to the eye, where they may have been united, so as to form an image of the object; because they issue again from those points in certain directions, in the same manner as they did from the corresponding points in the objects themselves. In fact, therefore, all that is effected by a telescope, is first to make such an image of a distant object, by means of a lens or mirror, and then to give the eye some assistance for viewing that image as near as possible; so that the angle, which it shall subtend at the eye, may be very large, compared with the angle which the object itself would subtend in the same situation. This is done by means of an eye-glass, which so refracts the pencils of rays, as that they may afterwards be brought to their several foci, by the natural humours of the eye. But if the eye had been so formed as to be able to see the image, with sufficient distinctness, at the same distance, without an eye-glass, it would appear to him as much magnified, as it does to another person who makes use of a glass for that purpose, though he would not, in all cases, have so large a field of view.

Although no image be actually formed by the foci of the pencil without the eye, yet if, by the help of an eye-glass, the pencils of rays shall enter the pupil, just as they would have done from any place without the eye, the visual angle will be the same as if an image had been actually formed in that place.

Telescopes are of several kinds, distinguished by the number and form of their lenses, or glasses, and denominated from their particular uses, &c. such are the "terrestrial, or land telescope," the "celes-

tial, or astronomical telescope;" to which may be added, the "Galilean, or Dutch telescope," the "reflecting telescope;" the "achromatic telescope," &c.

We shall proceed to describe some of these, in order to illustrate the principle.

The "astronomical telescope" consists of two convex lenses, A B, K M, Plate XVI. Miscel. fig. 1, fixed at the two extremities of a tube, that consists, at least, of two parts, that slide one within the other, for adjusting the focus in proportion to the distance of the objects that are to be seen through the telescope.

P Q represents the semi-diameter of a very distant object, from every point of which rays come, so very little diverging to the object lens, K M, of the telescope, as to be nearly parallel: *pq* is the picture of the object, P Q, which would be formed upon a screen situated at that place. Beyond that place, the rays of every single radiant point proceed divergingly upon another lens, A B, called the eye-glass, which is more convex than the former, and are, by this, caused to proceed parallel to one another, in which direction they enter the eye of the observer at O.

The two lenses of this telescope have a common axis, O L Q; L*q* is the focal distance of the object lens, and E*q* is the focal distance of the eye lens. An object viewed through this telescope, by an eye situated at O, will appear distinct, inverted, and magnified; *viz.* the object seen without the telescope will be, to its appearance through the telescope, as *q* E to *q* L; that is, as the focal distance of the eye lens to the focal distance of the object lens. For the rays, see OPTICS, which, after their crossing at the place, *r q p*, proceed divergingly, fall upon the lens, A B, in the same manner as if a real object were situated at *r q p*; and of course, on the other side of that lens the rays of each pencil will proceed parallel. Now to the eye at O, the apparent magnitude of the object, or of the part, P Q, is measured by the angle, E O A, or by its equal, *q* E *p*; but to the naked eye at L, when the glass is removed, the apparent magnitude of the object is measured by the angle, Q L P, or by its equal, *q* L *p*; therefore the apparent magnitude, to the naked eye, is to the apparent magnitude through the telescope, as the angle, *q* L *p*, is to the angle, *q* E *p*; or as the distance, *q* E, is to the distance, *q* L. This telescope is mostly used for astronomical observations; for, as it inverts the object, the representation of terrestrial objects through it would not be pleasant. It is evident, from the above explanation, that if the two lenses of this telescope have equal focal distances, the telescope will not magnify. It also appears, that, with a given object lens, the shorter the focus of the eye lens is, the greater will the magnifying power be. But when the disproportion of the two focal lengths is very great, then the aberration, arising from the figure of the lenses, and from the dispersive power of glass, becomes so very great as to do more damage than can be compensated by the increased magnifying power. Hence, in order to obtain a very great magnifying power, those telescopes have sometimes been made very long, as, for instance, of 100 feet, or upwards: and as they were used for astronomical purposes, or mostly in the night time, they were frequently used without a tube, *viz.* the object lens was fixed on the top of a pole, in a frame capable of motion in any required direction, and the eye lens was fixed in a short tube that was held in the hand of the observer. The distance, as well as the direction, of the two lenses, was adjusted by a strong cord stretched between the frame of the object lens and the tube of the eye lens. In this construction, the instrument has been called an "aërial telescope." Its use is evidently incommodious; but it was with such a telescope that five satellites of Saturn, and other remarkable objects, were discovered.

The object, which appears inverted through this telescope, will appear upright and distinct if two more convex eye glasses be subjoined to it, at a distance from each other, which is equal to the sum of their focal distances; and when their focal distances are equal, the object will be magnified as much as without those additional glasses; but through them it will appear upright, and not inverted. Hence this telescope has been mostly used for viewing terrestrial objects, and is therefore called the "terrestrial telescope."

The "Galilean telescope" consists of a convex object lens, and a concave eye lens, and derives its name from the great Galileo, who is generally reckoned the inventor of it. Fig. 2 shows, that the distance between the two lenses is less than the focal distance of the object lens; *viz.* instead of the convex lens situated behind the place of the image, to make the rays of each pencil proceed in a parallel direction to the eye, here a concave eye lens is placed as

much before that image; and this lens opens the rays of each pencil that converged to q and p, and makes them emerge parallel towards the eye as is evident by conceiving the rays to go back again through the eye lens, whose focal distance is E q.

The eye must be placed close to the concave lens, in order to receive as many pencils as possible; and then supposing an emerging ray of an oblique pencil to be produced backwards along A O, the apparent magnitude of the object is measured by the angle, A O E, or its equal, q E p, which is to the angle, q L p, or Q L P, as q L to q E, *viz.* as in the astronomical telescope. It is evident, that in this telescope the objects appear erect, for the rays of light do not cross each other.

The field of view, or quantity of objects that are taken in at once in this telescope, does not depend upon the breadth of the eye lens, as in the astronomical telescope, but upon the breadth of the pupil of the eye; because the pupil is less than the eye lens, A B, and the lateral pencils do not now converge to, but diverge from, the axis of the lenses. Upon this account the view is narrower in this than in the preceding telescope yet the objects through it appear remarkably clear and distinct.

"The night telescope is a short telescope, *viz.* about two feet long, which represents the objects inverted, much enlightened, but not much magnified. Its field of view is also very extensive. This telescope, in consequence of those properties, is used at night mostly by navigators, for the purpose of discovering objects that are not very distant, but which cannot otherwise be seen, for want of sufficient light; such as vessels, coasts, rocks, &c. On account of its extensive field, and great light, this telescope has also been advantageously used, by astronomers, for discovering some celestial objects, whose situation was not exactly known, or for viewing at once the relative situation of several stars and other objects.

This telescope has a pretty large and simple object lens, whence it derives its great light; for as the rays which proceed from every single point of the object fall upon the whole lens of a telescope, and are thence refracted to a focus, it is evident that the larger that lens is, the greater number of rays will be thrown upon that focus, and of course the brighter will the image be. In this telescope large lens may be used, because the telescope is not intended to magnify more than about four or [illegible] times in lineal extension.

Within this telescope a second lens is often used for shortening the focal length of the object lens. The eye lens is sometimes single, but mostly double, (*viz.* a combination of two plano-convex lenses placed at a little distance from each other) and pretty large: hence is derived the extensive field of view, which in some of these telescopes exceeds six or seven degrees.

We may observe, once for all, that in every telescope the distance between the object lens and the other lens or lenses must be alterable, in order that the focus may be adjusted according to the distance of the objects. Hence, every telescope consists at least of two tubes, one of which, viz. that with the eye lenses, slides within the other. To the same telescope several eye tubes, with a shallower or deeper lens, or with a different number of lenses, may be adapted successively, in order to give them different magnifying powers, suitably to the clearness of the air, of the objects, &c. and also for converting them into astronomical or terrestrial telescopes.

We now proceed to the reflecting telescope, which is likewise called the Newtonian telescope, for if not the original projector, Sir Isaac Newton is, at least, the first person who executed a telescope of this sort, which consists of reflecting and refracting parts.

The general principle of this telescope is the same as that of the dioptric or refracting telescope. In the latter the rays which come from a distant object are, by the action of the convex object lens, collected to a focus, and beyond that focus the rays of every single radiant point are rendered again parallel by the action of the eye lens or eye lenses. This is otherwise expressed, by saying that the object lens forms an image of the object, which image is viewed by the eye lens. In the former, *viz.* in the reflecting telescope, the rays which come from a distant object, are, by the action of a concave reflector sent back convergingly to a focus, where they form an image, which is viewed through the eye lens. There are several varieties of this telescope. We shall content ourselves with the description of one only, *viz.* the Gregorian telescope, which is represented in fig. 3. The large concave speculum, B E, of this telescope is perforated with a hole quite through its middle. Within the tube of the telescope a small concave speculum, x y, is supported

by the arm, H, directly facing the large speculum, B E. Two lenses, *w x* and *n o*, are contained in the eye tube, and the observer applies his eye to a small hole at P, in order to view a magnified distant object.

The large reflector, B E, receives the rays, *a c*, *b d*, from the distant object, and reflects them to its focus, *e*, where they form the inverted image, or where they cross each other, and then fall divergingly upon the small reflector, *x y*, whose focus is at *f*; *viz.* a little further than the focus, *e*, of the large reflector: hence the rays are reflected back upon the lens, *w x*, not in a parallel, but in a converging manner; and that convergency is increased by the action of that lens, so as to come to a focus, or to form a second image, R S, much larger than the former, and erect like the object. Lastly, this image is viewed through the eye lens, *n o*; or, in other words, the rays from every single point of the object, after this second crossing, fall divergingly upon the eye lens, which sends them nearly parallel to the eye at P, through a very small hole. Sometimes the eye lens, *n o*, is double, *viz.* it consists of two lenses, which perform the office of a single lens.

If the first lens, *w x*, were removed, the image would be formed somewhat larger at *z*; but the area or field of view would be smaller and less pleasant. At the place of the image, R S, there is situated a circular piece of brass, called a diaphragm, with a hole of a proper size to circumscribe the image, and to cut off all superfluous or extraneous light, in order that the object may appear as distinct as possible.

The magnifying power of this telescope is computed in the following manner: If this telescope consisted of the two reflectors only, and these were situated so that *e* were the focus of each reflector; then the rays which came parallel from the distant object to the large reflector, and divergingly from that to the small reflector, would, after the second reflection, go parallel to the eye at P, and of course the object would appear magnified in the proportion of the focal distance of the large reflector to the focal distance of the small reflector; so that if the focal distance of the former be to that of the latter as six to one, then the object would be magnified six times in diameter. But since the first image is magnified into a second image much larger, which is viewed through the eye lens; therefore the whole magnifying power is in a proportion compounded of *d e* to *e x*, and of *z x* to *z o*. If the former proportion be as six to one, and the latter as eight to one; then the object will appear forty-eight (*viz.* six by eight) times larger in diameter through the telescope than to the naked eye.

The fourth species of reflecting telescope goes under the name of "Cassegrainian Telescope." It differs from the preceding, in having the small reflector convex, instead of concave; in consequence of which the small reflector must be placed nearer to the large reflector than the focus of the latter; then the rays from the large reflector fall convergingly upon the convex small reflector, and are by it sent back convergingly upon the lens, *w x*, &c. The chief difference between this and the preceding telescope is, that in this the object appears inverted, because in it there is no image formed, or the rays do not cross each other, between the two reflectors. Also with the same magnifying power, &c. this telescope is shorter than the Gregorian, by twice the focal length of the small speculum.

To both those telescopes, a long wire is fixed all along the outside of the tube, at the end of which there is a screw which works into an external projection, *g*, of the internal arm, H, and serves to move that arm with the small speculum nearer to or further from the large speculum, in order to adjust the focus of the instrument, according to the distance of the object. The action of this wire is easily understood; for it passes through a hole at F, where it is prevented going forwards or backwards by two shoulders, which are indicated by the figure: hence, when the observer looks through the hole, P, he turns with his hand the wire by the nut, Q, which screws the projection, *g*, of the arm nearer or further, &c. until the object appears very distinct.

The largest reflecting telescope now existing, was constructed by that excellent astronomer, Dr. Herschel. It is a telescope in which the observer looks through an eye lens down upon the large reflector, whose polished surface is forty-eight inches in diameter. Its focal length is about forty feet.

There are however two useful appendages to telescopes, which deserve to be briefly described. A finder, *viz.* a short telescope A, fig. 3, is generally affixed to the tube of a large telescope, for the purpose of finding out an object expeditiously. This finder does not magnify the object more than four, six, or eight times; but it has a great field of view, so that through it

a great part of the heavens may be seen at once. In the inside of its tube, and exactly at the focus of the eye glass, there are two slender wires, which cross each other in the axis of the telescope. Now the finder is adjusted by means of screws upon the tube of the great telescope, in such a manner as that when an object, seen through the finder, appears to be near the crossing of the above-mentioned wires, it is at the same time visible through the great telescope: hence, when the observer wishes to view a small distant object, as a star, a planet, &c. he moves the instrument to one side or the other, until, by looking through the finder, he brings the object nearly to coincide with the crossing of the wires, and when that takes place, he immediately looks through the large telescope, &c.

A micrometer is an instrument, which is used with a telescope, for the purpose of measuring small angles. A great variety of micrometers have been contrived by various ingenious persons; and they are more or less complicated, more or less expensive, as also more or less accurate. See MICROMETER.

"Achromatic Telescope," is a name given to the refracting telescope, invented by Mr. John Dollond, and so contrived as to remedy the aberration arising from colours, or the different refrangibility of the rays of light. The improvement made by Mr. Dollond in his telescopes, by making two object-glasses of crown-glass, and one of flint which was tried with success when concave eye-glasses were used, was completed by his son Peter Dollond; who, conceiving that the same method might be practised with success with convex eye-glasses, found, after a few trials, that it might be done. Accordingly he finished an object-glass of five feet focal length, with an aperture of $3\frac{3}{4}$ inches, composed of two convex lenses of crown-glass, and one concave of white flint glass. But apprehending afterward that the apertures might be admitted still larger, he completed one of $3\frac{1}{2}$ feet focal length, with the same aperture of $3\frac{3}{4}$ inches. In the 17-inch improved achromatic telescope, the object-glass is composed of three glasses, viz, two convex of crown-glass, and one concave of white flint-glass: the focal distance of this combined object-glass is about seventeen inches, and the diameter of the aperture two inches. There are four eye-glasses contained in the tube, to be used for land objects; the magnifying power with these is near fifty times; and they are adjusted to different sights, and to different distances of the object, by turning a finger screw at the end of the outer tube. There is another tube, containing two eye-glasses that magnify about seventy times, for astronomical purposes. The telescope may be directed to any object by turning two screws in the stand on which it is fixed, the one giving a vertical motion, and the other a horizontal one. The stand may be inclosed in the inside of the brass tube.

The object-glass of the $2\frac{1}{2}$ and $3\frac{1}{2}$ feet telescopes is composed of two glasses, one convex of crown-glass, and the other concave of white flint glass; and the diameters of their apertures are two inches and $2\frac{3}{4}$ inches. Each of them is furnished with two tubes; one for land objects, containing four eye-glasses, and another with two eye-glasses for astronomical uses. They are adjusted by buttons on the outside of the wooden tube: and the vertical and horizontal motions are given by joints in the stands. The magnifying power of the least of these telescopes, with the eye-glass for land objects, is nearly fifty times, and with those for astronomical purposes, eighty times; and that of the greatest for land objects is nearly seventy times, but for astronomical observations eighty and a hundred and thirty times; for this has two tubes, either of which may be used as occasion requires. This telescope is also moved by a screw and rack-work, and the screw is turned by means of a hook's joint.

We must now say something of the specula of telescopes, having referred to this place from the article SPECULUM. The metals of reflecting telescopes are generally composed of thirty-two parts of copper and fifteen of grain tin, with the addition of two parts of arsenic, to render the composition more white and compact. It has been ascertained, by a variety of experiments, that if one part of brass, and one of silver, be added to this composition, and only one of arsenic used, a most excellent metal will be obtained, which is the whitest, hardest, and most reflective. The first composition is, however, for inexperienced persons, the best, as the easiest to cast, to grind, and polish. When this is employed, the copper and tin should be melted, and when mixed together should be poured into cold water, which will separate the mass into a number of small particles. These small pieces of metal are then to be collected and put into the crucible, along with the silver

and brass: after they have been melted together in a separate crucible, the proper quantity of arsenic is to be added, and a little powdered rosin thrown into the crucible before the metal is poured into the flasks. For the particular methods of grinding and polishing we refer to Brewster's edition of Ferguson's Mechanics, vol. i.

TELEPHIUM, in botany, a genus of the Pentandria Trigynia class and order. Natural order of Portulaceæ, Jussieu. Miscellaneæ, Linnæus. Essential character: calyx five-leaved; petals five, inserted into the receptacle; capsule one-celled, three-valved. There are two species, *viz.* T. imperati, true orpine; and T. oppositifolium, both natives of Barbary.

TELLER, an officer of the Exchequer, in ancient records called tallier: there are four of these officers, whose duty is to receive all sums due to the king, and to give the clerk of the pells a bill to charge him therewith. They likewise pay all money due from the king, by warrant from the auditor of the receipt, and make weekly and yearly books, both of their receipts and payments, which they deliver to the lord-treasurer.

TELLINA, in natural history, a genus of the Vermes Testacea class and order: animal a tethys: shell bivalve, generally sloping on one side; in the fore part of one valve a convex; of the other, a concave fold; hinge with usually three teeth, the lateral ones smooth, in one shell. There are about eighty species, divided into sections. A. ovate and thickish. B. ovate and compressed. C. suborbicular. We shall notice one or two only. T. gari: shell oval, with transverse recurved striæ; lateral teeth obsolete; it inhabits the Indian ocean: the fore part is inflected and very rough, with transverse wrinkles crossed in the middle by perpendicular striæ; sometimes cinereous, with brown rays; sometimes bluish spotted with white, and white and red rays. T. cornea: shell globular, glabrous, horn-colour, with a transverse groove. This Mr. Pennant has described in the British Zoology: it inhabits the ponds and fresh water of Europe: it is not larger than a pea. The shell is pellucid, very finely striate across; within bluish, white; without white, or pale or bluish-ash, with transverse black curves, one of which is more distinct; lateral teeth of the hinge elongated, hardly any middle ones.

TELL-TALE, in music, a moveable piece of ivory, or lead, suspended in the front of a chamber-organ, on one side of the keys, by a string; one side of the keys being attached to the bellows, within, rises as they sink, and apprizes the performer in what degree the wind is exhausted.

TELLURIUM. See SYLVAN.

TEMPERAMENT, in music, the accommodation or adjustment of the imperfect sounds, by transferring a part of their defects to the more perfect ones, in order to remedy, in some degree, the false intervals of those instruments, the sounds of which are fixed; as the organ, harpsichord, piano-forte, &c.

TEMPERING *of steel and iron*, the rendering them either more compact and hard, or soft and pliant, according as the different uses for which they are wanted may require.

The hardest steel is the most brittle; but in many cases it is necessary to diminish the hardness, and this operation is called tempering. The greatest difficulty consists in applying the proper degree of heat uniformly over the whole mass. The common method is, to judge by the colour assumed by the clean surface of steel when thus heated. The heat may be applied by the fire, or a pan of charcoal, or the flame of a candle or lamp, or by laying the piece upon sand to be gradually heated, or upon melted lead. Saw-makers, and those who manufacture springs, heat the article, rub it with grease, and then heat it further till the fumes take fire: this is called blazing, and affords a temper nearly the same as when the steel, by heat, has acquired a deep blue colour. When the temper is given from the colour, the first tinge is a faint straw colour: this is suitable to pen-knives and hard cutting tools. The next colour, which is purple, is rather too soft for a knife, and too brittle for a spring. After this follows the blue, of which there are several shades: the deepest is very soft, and this succeeded by a whitish-yellow, which indicates too great a degree of softness for any cutting tool. Mr. Hartley took out a patent for a method of tempering steel, which was done by heating the tools in oil raised to a high temperature. Pen-knives require a heat of 450° of Fahrenheit.

TEMPLARS, or TEMPLERS, a religious order instituted at Jerusalem, about the year 1118. Some religious gentlemen put themselves under the government of the patriarch of Jerusalem, renounced property, made the vow of celibacy and obedience, and lived like canons regular. King Baldwin assigned them an apartment in his

palace. They had likewise lands given them by the king, the patriarch, and the nobility, for their maintenance. At first there were but nine of this order, and the two principal persons were, Hugo de Paganis, and Geoffrey of St. Omers. About nine years after their institution, a rule was drawn up for them, and a white habit assigned them, by Pope Honorius II. About twenty years after this, in the popedom of Eugenius III. they had red crosses sewed upon their cloaks, as a mark of distinction; and in a short time they were increased to about three hundred, in their convent at Jerusalem. They took the names of Knights Templars, because their first house stood near the temple dedicated to our Saviour, at Jerusalem. This order, after having performed many great exploits against the infidels, became rich and powerful all over Europe; but the knights, abusing their wealth and credit, fell into great disorders and irregularities. Many crimes and enormities being alleged against them, they were prosecuted in France, Italy, and Spain; and at last, the pope, by his bull of the 22d of May, 1312, given in the council of Vienna, pronounced the extinction of the order of Templars, and united their estates to the order of St. John of Jerusalem.

TENACITY, a term applied to metals, by which is meant the power that a metallic wire, of a given diameter, has of resisting, without breaking, the action of a weight suspended from its extremity. The tenacity of different metals is very various: an iron wire, of one-tenth of an inch in diameter, will support, without breaking, about 5 cwt.; whereas one of lead will not support 30 lb.

TENAILLE, in fortification, a kind of outwork, resembling a hornwork, but generally somewhat different; for, instead of two demi-bastions, it bears only in front a re-entering angle between the same wings without flanks; and the sides are parallel. Tenaille, double or flanked, is a work whose front consists of four faces, making two re-entering angles, and three saliant; the wings or sides of this work being in like manner correspondent in the front of the gorge. Tenaille simple, a work having its front formed by two faces, which make a re-entering angle, the sides running directly parallel from the head to the gorge. Tenaille of the place, is that which is comprehended between the points of two neighbouring bastions; that is to say, the curtain, the two flanks that are raised on the curtain, and the two sides of the bastions which face one another; so that it is the same with what is otherwise called the face of the fortress. Tenaille of the foss, is a low work raised before the curtain in the middle of the foss: it is of three sorts; the first is composed of a curtain, two flanks, and two faces; the rampart of the curtain, including the parapet and talus, is but five fathom thick, but the rampart of the flanks and faces is seven. The second is composed only of two faces made on the lines of defence, whose rampart and faces are parallel. The third sort differs from the second, only in this, that its rampart is parallel to the curtain of the place. All three sorts are good, and cannot be hurt by the besiegers' cannon, till they are masters of the covert way, and have planted their cannon there.

TENANT, signifies one who holds or possesses lands or tenements by any kind of right, either in fee, for life, years, or at will.

TENCH. See Cyprinus.

TENDER, in law, is an offer to pay a debt, or perform a duty. This is often pleaded in an action as a bar to the plaintiff's recovery; and where the money demanded by the plaintiff has been tendered or offered to him before the commencement of the suit, and he has refused to accept it, the plaintiff is barred of his action and costs. In pleading a tender, the defendant says, the plaintiff ought not to have his action, because, except as to so much, specifying the sum, he owes nothing to the plaintiff; and as to that sum, he has been always ready and willing to pay it, and before the commencement of the suit tendered and offered it to the plaintiff, and that he refused it; which sum of money he of course brings into court, to be paid to the plaintiff, if he will accept the same; and this bringing money into court, on a plea of tender, is done without a special motion. In all other cases, the leave of the court must be had, before money can be brought into court. The rule under which this leave is granted, is, as in the case of an ejectment by a mortgage, founded upon a particular act of parliament. In other cases it is founded upon the discretionary power vested in the court. By the discretionary rule it is sometimes ordered, that upon bringing money into court all proceedings in an action shall be stayed. At other times it is ordered, that the money brought into court shall be struck out of the plaintiff's

declaration, and that the plaintiff shall not, at the trial of the issue, be permitted to give any evidence as to this money. This rule, by which the money brought into court is ordered to be struck out of the declaration, is from its being more frequently granted, than that by which it is ordered that the proceeding shall be stayed, called the common rule. Upon a pleas of tender the defendant must not plead the general issue, or a full denial as to the whole demand, but only to that part which is an excess above the sum tendered. And the plaintiff in answer to this must either deny the tender, or reply that there was a demand and refusal, which is a sufficient answer to the plea that states the defendant was always ready to pay. If Bank notes have been offered, and no objection made on that account, it has been considered by the Court of King's Bench as good tender. But to constitute a tender there must not merely be an offer by the defendant, that, if the plaintiff will take it, he will give him so much; but there must be an actual offer and readiness, accompanied with apparent ability, to pay immediately, although it is not absolutely necessary to produce the money in tale upon the table.

It is said, a Bank note is no tender, nor is it, if it is refused. But, by a late statute, before any one can be arrested, and held to bail, the plaintiff must swear that his debt has not been tendered to him in Bank notes, so that it is next to a legal tender; yet the plaintiff may sue by process, without holding to bail, and obtain judgment against the defendant, with his costs; on which the sheriff will levy, and probably tender the amount in Bank notes; so that the plaintiff will be put off in an endless circle, if it is worth while to incur costs, and Bank notes are now a legal tender in every thing but the name, which is, in the opinion of the best writers on political economy, a circumstance that must depreciate their real value.

Tender, a small ship, in the service of men of war, for carrying of men, provisions, or any thing else that is necessary.

TENDONS. Membranes are those parts of the body which include some of the internal parts of animals. Many of them are extremely thin, and they possess different degrees of transparency. They become pulpy by maceration in water, and by boiling are almost entirely converted into gelatine, so that they are chiefly composed of this substance. No phosphate of lime, nor other saline matter, has been detected in the membranous substances hitherto analyzed. Tendons are reduced by boiling to a gelatinous substance, so that they are composed of a similar matter with membranes. The ligaments afford a portion of gelatine by boiling, but are not, like the two former, entirely reduced to jelly, so that some other substance besides gelatine enters into the composition of ligaments.

TENEBRIO, in natural history, a genus of insects of the order Coleoptera. Antennæ moniliform, the last joint roundish; thorax plano-convex, margined; head projecting; shells rigid. There are about one hundred species, divided into sections. A. Feelers six, filiform; fore-shanks formed for digging. B. Feelers four. One of the most remarkable species is T. mortisagus, which is black, and about an inch long; it is slow in its motions, and distinguished by the remarkably pointed appearance of the wing-sheaths, which at their extremities project a little beyond the abdomen. It is found in dark, neglected places, beneath boards in cellars, and if handled, and especially if crushed, it gives out a very unpleasant smell. T. gibbosus, or, according to Dr. Shaw, T. globosus, is seen during the hottest part of summer about walls and pathways: it is distinguished by the globular appearance of the body. T. molitor, is an insect often found in houses, is coal black, and very small. It proceeds from a larva called the meal-worm, from its being commonly found in meal and bread. This is said to be the favourite food of nightingales. It remains two years before it changes into a chrysalis.

TENEMENT, in its common acceptation, is applied only to houses and other buildings; but in its original, proper, and legal sense it signifies every thing that may be holden, provided it be of a permanent nature, whether it be of a substantial or of an unsubstantial and ideal kind. Thus, frank tenement, or freehold, is applicable not only to lands and other solid objects, but also to offices, rents, commons, and the like; and as lands and houses are tenements, so is an advowson a tenement; and a franchise or office, a right of common, a peerage, or other property of the like unsubstantial kind, are all of them, legally speaking, tenements.

TENESMUS, in medicine, a name given by medical writers to a complaint which is a continual desire of going to stool,

but without any stool being ready to be voided.

TENNE, TENNY, or TAWNY, in heraldry, a bright colour made of red and yellow mixed; sometimes also called brusk, and expressed in engraving, by thwart, or diagonal strokes or hatches, beginning from the sinister chief, like purpure, and marked with the letter T. In the coats of all below the degree of nobles, it is called tenny; but in those of nobles, it is called hyacinth; and in prince's coats, the dragon's head.

TENNIS, a play at which a ball is driven by a racket, which requires great practice to make a good player, so that nothing can be done without it; all we presume to do is, to give an insight into the game, by which a person may not seem a total stranger to it when he happens to be in a tennis-court.

The game of tennis is played in most capital cities in Europe, particularly in France, whence we may venture to derive its origin. It is esteemed, with many, to be one of the most ancient games in Christendom, and long before King Charles I.'s time it was played in England. This game is as intricate as any game whatever; a person who is totally ignorant of it may look on for a month together, without being able to make out how the game is decided.

The size of a tennis-court is generally about 96 or 97 feet by 33 or 34, there being no exact dimension ascribed to its proportion, a foot more or less in length or width being of no consequence. A line or net hangs exactly across the middle, over which the ball must be struck, either with a racket or board, to make the stroke good. Upon the entrance of a tennis-court, there is a long gallery which goes to the dedans, that is, a kind of front gallery, where spectators usually stand; into which whenever a ball is struck, it tells for a certain stroke. This long gallery is divided into different compartments or galleries, each of which has its particular name, as follows; from the line towards the dedans are the first gallery, door, second gallery, and the last gallery, which is called the service side. From the dedans to the last gallery are the figures 1, 2, 3, 4, 5, 6, at a yard distance each, by which the chaces are marked, and is one of the most essential parts of the game, as will appear in the following description.

On the other side of the line are also the first gallery, door, second gallery, and last gallery, which is called the hazard-side. Every ball struck into the last gallery on this side reckons for a certain stroke the same as the dedans. Between the second and this last gallery are the figures 1, 2, to mark the chaces on the hazard-side. Over this long gallery, or these compartments, is a covering, called the penthouse, on which they play the ball from the service-side, in order to begin a set of tennis, from which it is called a service. When they miss putting the ball (so as to rebound from the penthouse) over a certain line on the service-side, it is deemed a fault, two of which are reckoned for a stroke. If the ball rolls round the penthouse, on the opposite of the court, so as to fall beyond a certain line described for that purpose, it is called passe, reckons for nothing on either side, and the player must serve again.

On the right-hand side of the court from the dedans is what they call the tambour, a part of the wall which projects, and is so contrived in order to make a variety in the stroke, and render it more difficult to be returned by the adversary; for when a ball strikes the tambour, it varies its direction, and requires some extraordinary judgment to return it over the line. The last thing on the right-hand side is called the grill, wherein if the ball is struck, it is also 15, or a certain stroke.

The game of tennis is played by what they call sets; a set of tennis consists of six games: but if they play what is called an advantage-set, two above five games must be won on one side or the other successively, in order to decide; or, if it comes to six games all, two games must still be won on one side to conclude the set; so that an advantage-set may last a considerable time; for which kind of sets the court is paid more than for any other.

We must now describe the use of the chaces, and by what means these chaces decide or interfere so much in the game. When the player gives his service at the beginning of a set, his adversary is supposed to return the ball; and wherever it falls after the first rebound untouched, the chace is called accordingly; for example, if the ball falls at the figure 1, the chace is called at a yard, that is to say, at a yard from the dedans: this chace remains till a second service is given; and if the player on the service-side lets the ball go after his adversary returns it, and if the ball falls on or between any of these figures or chaces, they must change sides, there being two

chaces; and he who then will be on the hazard-side, must play to win the first chace; which if he wins by striking the ball so as to fall, after its first rebound, nearer to the dedans than the figure 1, without his adversary's being able to return it from its first hop, he wins a stroke, and then proceeds in like manner to win the second chace, wherever it should happen to be. If a ball falls on the line with the first gallery door, second gallery, or last gallery, the chace is likewise called at such or such a place, naming the gallery-door, &c. When it is just put over the line, it is called a chace at the line. If the player on the service-side returns a ball with such force as to strike the wall on the hazard-side so as to rebound, after the first hop over the line, it is also called a chace at the line.

The chaces on the hazard-side proceed from the ball being returned either too hard or not quite hard enough; so that the ball after its first rebound falls on this side of the blue line, or line which describes the hazard-side chaces; in which case it is a chace at 1, 2, &c. provided there is no chace depending. When they change sides, the player, in order to win this chace, must put the ball over the line any where, so that his adversary does not return it. When there is no chace on the hazard-side, all balls put over the line from the service-side, without being returned, reckon for a stroke.

As the game depends chiefly upon the marking, it will be necessary to explain it, and to recommend those who play at tennis to have a good and unbiassed marker, for on him the whole set may depend: he can mark in favour of the one and against the other in such a manner, as will render it two to one at starting, though even players. Instead of which the marker should be very attentive to the chaces, and not be any way partial to either of the players.

This game is marked in a very singular manner, which makes it at first somewhat difficult to understand. The first stroke is called 15, the second 30, the third 40, and the fourth game, unless the players get four strokes each; in that case, instead of calling it 40 all, it is called deuce; after which, as soon as any stroke is got, it is called advantage; and in case the strokes become equal again, deuce again, till one or the other gets two strokes following, which win the game; and as the games are won, so they are marked and called; as one game love, two games to one, &c. towards the set, of which so many of these games it consists.

Although but one ball at a time is played with, a number of balls are made use of at this game to avoid trouble, and are handed to the players in baskets for that purpose; by which means they can play as long as they please, without ever having occasion to stoop for a ball.

TENON, in building, &c. the square end of a piece of wood, or metal, diminished by one third of its thickness, to be received into a hole in another piece, called a mortise, for the jointing or fastening the two together. It is made in various forms, square, dove-tailed for double mortises, and the like.

TENOR, or TENORE, in music, the first mean, or middle part, or that which is the ordinary pitch of the voice, when neither raised to a treble, or lowered to a bass. The tenor is commonly marked in thorough bass with the letter T. This is that part which almost all grown persons can sing; but as some have a greater compass of voice upwards, others downwards, others are confined to a kind of medium, and others can go equally high or low; hence musicians make a variety of tenors, as a low, a high, a mean, a natural tenor, to which may be added, a violin tenor, &c. for instruments.

TENSE, TIME, in grammar, an inflection of verbs, whereby they are made to signify, or distinguish the circumstance of time, in what they affirm.

TENSION, the state of any thing stretched as a line, &c. Thus animals sustain and move themselves by the tension of their muscles and nerves: a chord, or musical string, gives an acuter or deeper sound, as it is in a greater or less degree of tension, that is, more or less stretched.

TENT, in surgery, a roll of lint worked into the shape of a nail, with a broad flat head.

TENTER, a machine used in the cloth manufacture, to stretch out the pieces of cloth, stuff, &c. or only to make them even, and set them square. It is usually about four feet and a half high, and for length exceeds that of the longest piece of cloth. It consists of several long pieces of wood, placed like those which form the barriers of a manege; so that the lower cross piece of wood may be raised or lowered, as is found requisite, to be fixed at any height, by means of pins. Along the cross pieces, both the upper and under one, are hooked

nails, called tenter hooks, driven in from space to space.

TENTHREDO, in natural history, *saw-fly*, a genus of insects of the order Hymenoptera: mouth with a horned curved mandible, toothed within, the jaw straight and obtuse at the lip, the lip cylindrical bifid; four feelers, unequal filiform; wings tumid, the lower ones less; sting composed of two serrate laminæ, and almost secreted. There are about one hundred and fifty species, in divisions, distinguished by the antennæ. A. antennæ clavate; B. antennæ inarticulate, thicker at the tip; C. antennæ pectinate; in D, they are filiform, with from seven to nine articulations; in E they are filiform, with numerous articulations. The insects of this genus feed on the leaves of various plants; the female uses her sting in the manner of a saw, hence the common name. It cuts out spaces in the twigs or buds of trees for the purpose of depositing her eggs. The larvæ resemble those of the order Lepidoptera, or real caterpillars, from which they may be distinguished by their more numerous feet, which are never fewer than sixteen, though they are sometimes found with as many as twenty-eight. It feeds on the leaves of plants, and when touched, rolls itself up spirally. The pupa is folliculate; the eggs increase in size every day till the larvæ burst from them. The larvæ of the smaller species are often injurious to different kinds of esculent vegetables.

TENURE, the manner whereby lands or tenements are holden, or the service that the tenant owes to his lord. Under the word tenure, is included every holding of an inheritance; but the signification of this word, which is a very extensive one, is usually restrained by coupling other words with it; this is sometimes done by words, which denote the duration of the tenant's estate: as if a man hold to himself and his heirs, it is called tenure in fee-simple. At other times the tenure is coupled with words pointing out the instrument by which an inheritance is held: thus, if the holding be by copy of court roll. At other times this word is coupled with others that show the principal service by which an inheritance is held; as where a man held by knight's service, it is called tenure by knight's service.

TERAMNUS, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: keel very small concealed within the calyx; stamina alternate, five-barren; stigma sessile, headed. There are two species, *viz.* T. volubulis, and T. uncinatus, both natives of Jamaica.

TEREBELLA, in natural history, a genus of the Vermes Mollusca class and order. Body oblong, creeping, naked, often inclosed in a tube, furnished with lateral fascicles or tufts, and branchiæ mouth placed before, furnished with lips, without teeth, and protruding a clavate proboscis; feelers numerous, ciliate, capillary, seated round the mouth. There are eleven species.

TEREDO, in natural history, *ship-worm*, a genus of the Vermes Testacea class and order. Animal a terrebella, with two calcareous hemispherical valves cut off before, and two lanceolate ones; shell tapering, flexuous, and capable of penetrating wood. There are three species.

T. navalis, shell very thin, cylindrical, smooth; found in the sides and bottoms of ships, and the stoutest oak pales, which have remained some time under water, and was imported from India. The destruction which these worms effect under water is almost equal to that of the Termes, or white ant, on land. The shell is more or less twisted, rather obtuse at the lip, and from four to six inches long (See TERMES). They will appear, on a very little consideration, to be most important beings in the great chain of creation, and pleasing demonstrations of the infinitely wise and gracious Power which formed, and still preserves, the whole in such wonderful order and beauty; for if it was not for the rapacity of these and such animals, tropical rivers, and indeed the ocean itself, would be choked with the bodies of trees which are annually carried down by the rapid torrents, as many of them would last for ages, and probably be productive of evils, of which, happily, we cannot in the present harmonious state of things form any idea; whereas now being consumed by these animals, they are more easily broken in pieces by the waves; and the fragments which are not devoured become specifically lighter, and are consequently more readily and more effectually thrown on shore, where the sun, wind, insects, and various other instruments, speedily promote their intire dissolution.

TERM, in geometry and algebra, is the extreme of any magnitude, or that which bounds and limits its extent. Thus the terms of a line, are points; of a superficies, lines; of a solid, superficies. The terms of an equation are the several names or members of

which it is composed, separated from one another by the signs + or —. Thus the quantity $az + 2bc - 3az^2$ consists of three terms, az and $2bc$ and $3az^2$. In an equation, the terms are the parts which contain the several powers of the same unknown letter or quantity: for if the same unknown quantity be found in several members in the same degree or power, they pass for one term, which is called compound, in distinction from a simple or single term: thus in the equation $x^3 + \overline{a - 3b}\,x^2 - acx = b^3$, the four terms are x^3 and $\overline{a - 3b}.\,x^2$ and acx and b^3: of which the second term $\overline{a - 3b}.\,x^2$ is compound, and the other three are simple terms. The terms of a product, or of a fraction, or of a ratio, or of a proportion, &c. are the several quantities employed in forming or composing them: thus the terms of the product ab are a and b: — of the fraction $\frac{7}{9}$ they are 7 and 9: — of the ratio 8 : 9 they are 8 and 9: and of the proportion $a : b :: x : y$, the terms are a, b, x, and y.

TERM *in the arts*, or TERM *of art*, is a word which, besides the literal and popular meaning which it has, or may have, in common language, bears a further and peculiar meaning in some art or science.

TERM, in logic. A proposition is said to consist of two terms, *i. e.* two principal and essential words, the subject, and the attribute.

TERMS, are those spaces of time in which the courts of justice are open for all that complain of wrongs or injuries, and seek their rights by course of law or action, in order to their redress, and during which the courts in Westminster-hall sit and give judgment, &c. But the high court of Parliament, the Chancery, and inferior courts, do not observe the terms; only the courts of King's Bench, Common Pleas, and Exchequer, the highest courts at common law. Of these terms there are four in every year, *viz.* Hilary Term, which begins the 23d of January, and ends the 12th of February, unless on Sundays, and then the day after; Easter Term, which begins the Wednesday fortnight after Easter-day, and ends the Monday next after Ascension-day; Trinity Term, which begins the Friday after Trinity Sunday, and ends the Wednesday fortnight after; and Michaelmas Term, which begins the 6th, and ends the 28th of November.

There are, in each of these terms, stated days, called days in bank, that is days of appearance in the Court of Common Pleas, called usually *bancum*, or *commune bancum*, to distinguish it from *bancum regis*, or the Court of King's Bench. They are generally at the distance of about a week from each other, and regulated by some festival of the church. On some of these days in bank, all original writs must be made returnable, and therefore they are generally called the returns of that term; the first return in every term is, properly speaking, the first day in that term, and thereon the court sits to take essoins, or excuses for such as do not appear according to the summons of the writ; wherefore this is usually called the essoin day of the term. But the person summoned hath three days grace beyond the return of the writ, in which to make his appearance; and if he appear on the fourth day inclusive, *quarto die post*, it is sufficient. Therefore, at the beginning of each term, the court doth not sit for dispatch of business till the fourth day, and in Trinity Term, by statute 32 Henry VIII. c. 21. not till the sixth day.

TERMS, *Oxford*. Hilary, or Lent Term, begins on January 14, and ends the Saturday before Palm Sunday. Easter Term begins the tenth day after Easter, and ends the Thursday before Whit Sunday. Trinity Term begins the Wednesday after Trinity Sunday, and ends after the act, sooner or later, as the Vice Chancellor and Convocation please. Michaelmas Term begins on October 10, and ends December 7.

TERMS, *Cambridge*. Lent Term begins on January 13, and ends the Friday before Palm Sunday. Easter Term begins the Wednesday after Easter week, and ends the week before Whit Sunday. Trinity Term begins the Wednesday after Trinity Sunday, and ends the Friday after the commencement. Michaelmas Term begins October 10, and ends December 16.

TERMS, *Scottish*. In Scotland, Candlemas Term begins January 23, and ends February 12. Whitsuntide Term begins May 25, and ends June 15. Lammas Term begins July 20, and ends August 8. Martinmas Term begins November 3, and ends November 29.

TERMS, *Irish*, are the same as those in London, except that at Michaelmas, which commences October 13, and adjourns to the beginning of November.

TERMES, in natural history, a genus of insects of the order Aptera. Mouth with two horny jaws; lip horny, four-cleft, the divisions linear and acute; four feelers,

equal, filiform; two eyes. There are ten species, in two sections: A. antennæ moniliform; B. antennæ setaceous.

T. fatale, or white ant, is brown above; thorax with three segments; wings pale with a testaceous rib. A most curious and wonderful account of this insect is given in the Philosophical Transactions, of which we shall notice a few particulars. The animal of this extraordinary community, far exceeding in wisdom and policy the bee, the ant, or beaver, are inhabitants of East India, Africa, and South America. They build pyramidal structures ten or twelve feet in height, and divided into appropriate apartments, magazines for provisions, arched chambers; and galleries of communication. These are so firmly cemented that they easily bear four men to stand upon them, and in the plains of Senegal appear like the villages of the natives. With such wonderful dexterity and rapidity they destroy food, furniture, books, clothes, and timber of whatever magnitude, leaving a mere thin surface; that in a few hours a large beam will be eaten to a mere shell, not thicker than writing paper. Larva small, about a quarter of an inch long; six-footed, pale, with a roundish testaceous head; eyes none; mandibles short, strong, and toothed; antennæ as long as the thorax and ovate abdomen. These only are the labourers, who build the structures, procure provisions for the males and females, and take care of the eggs: they are the most numerous. Pupa larger, about half an inch long, with a very large ovate polished testaceous head; eyes none; mandibles projecting, as long as the head, forked, without teeth, sharp and black; thorax and abdomen palish.

These never work, but act as superintendants over the labourers, or as guards to defend their habitations from intrusion and violence. When a breach is made in the dwelling, they rush forward and defend the entrance with great ferocity; some of them beating with their mandibles against any hard substance, as a signal to the other guards, or as encouragement to the labourers; they then retire and are succeeded by the labourers, each with a burthen of tempered mortar in his mouth, and who diligently set about to repair whatever injury has been sustained. One of these attends every six or eight hundred labourers who are building a wall, taking no active part himself, but frequently making the noise above mentioned, which is constantly answered by a loud hiss from all the labourers, who at this signal evidently redouble their diligence.

The male and female are alike, and furnished with four long horizontal wings; head small, brown; mandibles short, acute, toothed; antennæ yellowish; eyes globular, prominent, black; thorax with three brown or dull testaceous margined segments; abdomen ovate; the back brown, with white streaks; legs palish.

These are extricated from the pupa state and fly abroad in the night; but soon after sun rise, the wings become dry and they fall on the ground, and are devoured by birds, or sought after by the inhabitants, who roast and eat them with great avidity. A few that survive are collected by the labourers or larvæ, and inclosed by pairs in apartments made of clay, the aperture of which is narrowed so that they cannot migrate, and where they are diligently fed and attended by the labourers whose bodies are small enough to admit an easy entrance.

After impregnation, the abdomen of the female grows to a prodigious bulk, exceeding the rest of her body nearly two thousand times; it is then vesicular and white, with transverse brown spots, and an undulate or slightly lobed margin. In this state it contains an immense number of small round brown eggs, which are protruded to the amount of eight thousand in twenty-four hours. These are instantly taken up by the labourers, and conveyed to separate chambers, where after they are hatched, the young are attended and provided for till they are able to shift for themselves, and take their share in the labours of the community.

T. pulsatorius is a very small insect, frequently found during the summer months in houses, particularly where the wainscot is in any degree decayed, and is remarkable for continuing a long continued sound, resembling the ticking of a watch. It is very common in collections of dried plants, which it injures very much. It is of so tender a frame as to be easily destroyed by the slightest pressure, and is an animal of very quick motions. When this insect is first hatched, it bears a complete resemblance to a common mite, but after awhile casts its skin, and undergoes a complete change.

TERMINALIA, in botany, a genus of the Polygamia Monoecia class and order. Natural order of Elæagni, Jussieu. Essential character: calyx five-parted; corolla

none; stamens ten; hermaphrodite, style one; drupe inferior, boat-shaped. There are six species, natives of the East and West Indies.

TERNSTROEMIA, in botany, so named in memory of Ternstroem, known by his travels into China, a genus of the Polyandria Monogynia class and order. Natural order of Columniferæ. Aurantia, Jussieu. Essential character: calyx five-parted; corolla one-petalled, wheel-shaped, with the border bell-shaped, five or six-parted; anthers thick at the tip; berry juiceless, two-celled. There are five species.

TERELLA, an appellation given to a loadstone, when turned into a spherical figure, and is placed so, that its poles and equator, &c. correspond to the poles and equator of the world; as being a just representation of the great magnetical globe which we inhabit.

TERRIER, a book, or roll, wherein the several lands, either of a private person, or of a town, college, church, &c. are described. It should contain the number of acres, and the scite, boundaries, tenants, names, &c. of each piece or parcel.

TEST, in metallurgy, a vessel of the nature of the coppel, used for large quantities of metals at once. See ASSAYING.

TESTACEA, in natural history, an order of the class Vermes in the Linnean system. It is described as a Mollusca, that is, a soft animal, of a simple structure, covered with a calcareous habitation or shell. There are in this order thirty-six genera, in sections.

A. Multivalves: shells with many valves.

Chiton	Pholas
Lepas	

B. Bivalves: shell with two valves.

Anomia	Mytilus
Anomia	Ostrea
Cardium	Pinna
Chama	Solen
Donax	Shondylus
Mactra	Tellina
Mya	Venus.

C. Univalves, with a regular spire.

Argonauta	Murex
Buccinum	Nautilus
Bulla	Nerita
Conus	Spombus
Cypræa	Trochus
Haliotis	Turbo
Helix	Voluta.

D. Univalves, without a regular spire.

Dentalium	Tabella
Patella	Teredo.
Serpula	

TESTES. See ANATOMY.

TESTUDO, the *tortoise*, in natural history, a genus of Amphibia of the order Reptiles. Generic character: body tailed, covered above and beneath, defended by a bony covering, covered by a horny, scaly, or coriaceous integument; a bony mouth, without distinct teeth, and the upper mandible closing over the lower. These animals feed on sea-weeds or on worms, are extremely prolific; but in the state of eggs, and while very young, are the prey of various animals. Their movements are slow; they are capable of being tamed, and will in that state eat almost any thing presented to them. They exist long in such air as would be destructive to other animals of the same size, and have such tenaciousness of life, that it is stated they will exhibit convulsive movements for several days after their bodies have been opened, and even after their heads have been cut off. In cold latitudes the land tortoise is torpid during the winter. There are thirty-five species, of which we shall notice the following. T. Græca, or the common tortoise. The weight of this animal is three pounds, and the length of its shell about seven inches. It abounds in the countries surrounding the Mediterranean, and particularly in Greece, where the inhabitants not only eat its flesh and eggs, but frequently swallow its warm blood. In September or October it conceals itself, remaining torpid till February, when it reappears. In June it lays its eggs, in holes exposed to the full beams of the sun, by which they are matured. The males will frequently engage in severe conflicts, and strike their heads against each other with great violence, and very loud sounds. Tortoises attain most extraordinary longevity, and one was ascertained to have lived in the gardens of Lambeth to the age of nearly 120 years. Its shell is preserved in the archiepiscopal palace. So reluctant is the vital principal to quit these animals, that Shaw informs us, from Redi, one of them lived for six months after all its brain was taken cut, moving its limbs, and walking as before. Another lived twenty-three days after its head was cut off, and the head itself opened and closed its jaws for a quarter of an hour after its separation from the body. It may not only be tamed, but has in several instances exhibited proofs in that state

of considerable sagacity, in distinguishing its benefactors, and of grateful attachment in return for their kindness, notwithstanding its general sluggishness and torpor. It will answer the purpose of a barometer, and uniformly indicates the fall of rain before night, when it takes its food with great rapidity, and walks with a sort of mincing and elate step. It appears to dislike rain with extreme aversion, and is discomfited and driven back only by a few and scarcely perceivable drops. See Amphibia, Plate II. fig. 4.

T. lutaria, or the mud tortoise, is common both in Europe and Asia, and particularly in France, where it is much used for food. It is seven inches long; lays its eggs on the ground, though an aquatic animal; walks quicker than the land tortoise; and is often kept in gardens, to clear them from snails and various wingless insects. In fish-ponds it is very destructive, biting the fishes, and, when they are exhausted by the loss of blood, dragging them to the bottom and devouring them.

T. ferox, or the fierce tortoise, is found in several parts of North America, and is eighteen inches long. It is rapid and vigorous in its movement, and will spring on its enemy with great elasticity and violence. Its flesh is thought extremely good. It is found in the muddy parts of rivers, concealing itself among the weeds. It will also dart with great celerity on birds. The sea tortoises, or turtles, are distinguished from the former by having very large and long feet, in the shape of fins, the claws of some of the toes not being visible, but inclosed.

T. mydas, or the common green turtle, is not unfrequently five feet long, and of the weight of 500 pounds; and is denominated green, from a shade of that colour assumed by the fat when the animal is in its perfect state. In the West Indies it has been long in the highest estimation for the table, and within sixty or seventy years it has gradually been advancing in reputation in this country for food, and is at present considered as furnishing the highest gratification of epicurism. It is imported into England in vast numbers. It feeds on sea grass called turtle grass. It is taken sometimes after being watched to its haunts; and being thrown on its back, is unable to rise again on its feet; sometimes it is struck in the water with a long staff, armed with iron at the end. The markets of the West Indies are supplied with the flesh of these animals as those of Europe are with mutton and beef, and before they were much sought as articles of exportation, forty sloops were employed by the inhabitants of Port Royal in catching them. They are seldom seen on land but at the season of laying their eggs, which they do at several times, after intervals of fourteen days. They are occasionally found, probably in consequence of tempests, on the coasts of Europe.

T. imbricata, or the imbricated turtle, or hawksbill, is so called from its shells lapping one over another, like tiles on the roof of a house. It is about three feet long; is found in the seas both of Asia and America, and sometimes also in the Mediterranean; and is said to have been seen even of 600 pounds weight. Its flesh is in no estimation; but its lamina are manufactured into that elegant material known by the name of tortoise-shell, which has been applied by human ingenuity to innumerable purposes both of use and ornament. The thickness of the plates varies in reference to the age and size of the turtle. Those of a very young one are of no value. A large one will supply ten pounds weight of valuable scales, which being softened by heat, and lapped over each other, by means of pressure become effectually united, so as to constitute one piece of considerable extent, and without any perceivable trace of their separation. This article was well known to the Greeks and Romans, and was an important material of luxury and commerce. Various articles of furniture, and even beds, were inlaid with it. The Egyptians exported large cargoes of it to Rome for these purposes, and in China, as well as Europe, it is at present in very high demand for elegant and ornamental manufactures.

Testudo, in the military art of the ancients, was a kind of cover or screen which the soldiers, *e. gr.* a whole company, made themselves of their bucklers, by holding them up over their heads, and standing close to each other. This expedient served to shelter them from darts, stones, &c. thrown upon them, especially those thrown from above, when they went to the assault.

Testudo was also a kind of large wooden tower which moved on several wheels, and was covered with bullock's hides flead, serving to shelter the soldiers when they approached the walls to mine them, or to batter them with rams.

TETHER, a string by which horses are held from ranging too far in pastures, &c. In figurative language, we say to go the

length of one's tether; to speak or act with as much freedom as circumstances will admit.

TETHYS, in natural history, a genus of the Vermes Mollusca class and order: body detached, rather oblong, fleshy, without peduncles; mouth with a terminal, cylindrical proboscis, under an expanded membrane or lip; two apertures on the left side of the neck. There are two species, *viz.* T. leporina, which inhabits the Mediterranean, and T. fimbria, found in the Adriatic.

TETRACERA, in botany, a genus of the Polyandria Tetragynia class and order. Natural order of Rosaceæ, Jussieu. Essential character; calyx five or six-leaved; corolla four or five-petalled; filaments widening above; and anther bearing on each side; capsules four, opening on the side; seed arilled at the base. There are twelve species.

TETRACHORD, in the ancient music, a concord consisting of four degrees or intervals, and four terms or sounds; called also by the ancients diatessarron, and by us a fourth.

TETRADYNAMIA, in botany, the name of the fifteenth class in the Linnæan system, consisting of plants with hermaphrodite flowers, having six stamina, four of which are longer than the rest. There are two orders in this class, *viz.* the siliquosæ, those that have long pods, as stocks, rockets, &c.; and the siliculosæ, or those that have short round pods, as scurvy-grass, candy-tuft, &c.

TETRAEDRON, or TETRAHEDRON, in geometry, one of the five regular or platonic bodies or solids, comprehended under four equilateral and equal triangles.

It is demonstrated by mathematicians, that the square of the side of a tetraedron is to the square of the diameter of a sphere, wherein it may be inscribed, in a subsequilateral ratio: whence it follows, that the side of a tetraedron is to the diameter of a sphere it is inscribed in, as $\sqrt{2}$, to the $\sqrt{3}$, consequently they are incommensurable.

TETRAGONIA, in botany, a genus of the Icosandria Pentagynia class and order. Natural order of Succulentæ. Ficoideæ, Jussieu. Essential character: calyx three to five-parted; petals none; drupe inferior, inclosing a nut from three to eight-celled. There are eight species, chiefly natives of the Cape of Good Hope.

TETRAGYNIA, in botany, the name of an order in certain classes of the Linnæan system, consisting of plants, which, to the classic character, add the circumstance of having four styles.

TETRANDRIA, in botany, the name of the fourth class in the Linnæan system, consisting of plants with hermaphrodite flowers, which have four stamina of equal length. In this last circumstance consists the main difference between the tetrandria and the didynamia, in which the four stamina are of unequal length, two of them being longer than the other two. There are three orders in this class, founded upon the number of styles.

TETRANTHUS, in botany, a genus of the Syngenesia Polygamia Segregata class and order. Natural order of Capitatæ. Cinarocephalæ, Jussieu. Essential character: calyx common, four-flowered; perianth proper, one-leafed; seeds crowned. There is but one species, *viz.* T. littoralis, an annual plant, and a native of Hispaniola.

TETRAO, in natural history, a genus of birds of the order Gallinæ. Generic character: near each eye a spot which is naked, or papillous, or slightly covered with feathers. Birds of this genus, which, according to Gmelin, comprehends the grouse, the partridge, and the quail, follow the dam immediately on being hatched, and before the shell is wholly detached from them; their bill is strong and convex, and their flesh and eggs form an exquisite repast. There are seventy-three species, of which the following are best deserving of notice.

T. urogallus, or the cock of the wood, is of the size of a turkey, and is found from Russia to Italy, preferring the elevated and mountainous parts of temperate countries, as it delights in a cold temperature. Its eggs are deposited on moss, and whenever left by the female, who is unassisted in the process of incubation, are covered over with leaves. The males and females live separate, except during the months of February and March. Their food consists of various plants and grains, and of buds of trees. The seeds of the pine and fir they are particularly fond of. The sound of the male resembles not a little the whetting of a scythe. These birds are in high request for the table, and are sometimes sent from Petersburg to London, in a very rigorous winter, arriving, it is said, in good condition.

T. tetrix, or the black grouse, is larger than a common fowl, and abounds in the British islands, particularly in the northern districts. In winter these birds shelter themselves in low situations. On the return

of spring they withdraw to the mountains, and contests occur between the males, which are carried on with extreme violence and fury, and during which they are so agitated by rage, that they may be approached without observation, and knocked down with a club. The birds of this species, and of the last, do not pair like other birds, and the male is generally seen with several females in his train. They subsist on seeds and herbage, and are particularly fond of the seeds of the birch and Siberian poplar.

T. Canadensis, or the spotted grouse, is thirteen inches long, abounds in the neighbourhood of Hudson's Bay, and feeds upon juniper berries, and the cones of spruce. These birds are eaten by the natives, both in summer and winter, during the latter season being hung up by the bill, and preserved by the frost. They are extremely stupid, and will scarcely make an effort to evade danger.

T. lagopus, or the ptarmigan grouse, is fourteen inches long, and inhabits the north of Europe. It is not uncommon in the Orknies and the Hebrides, and is sometimes found in Cumberland. These birds subsist on seeds, fruits, and berries, and are like the last, silly and inadvertent to danger.

T. perdix, or the common partridge, is thirteen inches long, and abounds in the temperate regions of Europe. It is unable to sustain rigorous cold, or intense heat. It feeds on green corn and other plants, and almost every species of grain; but the eggs of ants constitute its favourite food, and are almost essential for the nourishment and preservation of the young ones. Experiments have been repeatedly, but ineffectually, made, to induce the breeding of this bird in confinement; its eggs, however, are frequently introduced into the nest of a common hen, and are thus matured, and the young are treated affectionately by that bird, and may be brought to perfection if provided with their appropriate food. The attachment of the male and female partridge to their offspring is highly interesting. They both sit, covering them frequently at the same time, and, when danger approaches, will expose themselves to its direct attack, in order to decoy the attention of the enemy from those whose security they prefer even to their own existence. They pair early, build with dry leaves upon the ground, and the young run after their parent as soon as they are extricated from the shell. They breed in England only once a year, and live to the age of twelve years. They are highly valued for food.

T. coturnix, or the quail, is between seven and eight inches long, and inhabits almost every country of the old world, but is not found in America. It is migratory, and moves in spring towards the colder climates, returning southerly in autumn. In these progresses quails fly in immense multitudes, and are taken in the islands of the Archipelago in such numbers as for a short time to be the principal article of food for the inhabitants, and to constitute an important source of income and revenue. Within a few miles, along the coasts of Italy, a hundred thousand are said to have been taken in a single day. Latham informs us, that they used to be an article of importation from France to England, in cages formed with several divisions, and containing about a score of birds in each, and that he had often seen these cages filled with them, and attached to the stage coaches between Paris and London. They breed, however, in this country, and though many migrate beyond the island, many only change their residence within it, on the approach of winter, from the more exposed to the more sheltered parts. These birds were proverbial among the Romans for captiousness and quarrelling, and are employed among the Chinese for the same amusement as game cocks in England. They were so used, indeed, likewise among the ancients. It appears highly probable that the extraordinary supplies of the Israelites were derived from this species of birds, in their vast flights to and from Africa, and though represented in the Jewish history as a permanent supply, this circumstance may easily be accounted for from the exaggerating and superlative phraseology which characterizes all oriental description.

TETRATOMA, in natural history, a genus of insects of the order Coleoptera. Antennæ clavate, the club perfoliate; lip rounded, entire; feelers thickish, unequal; shells as long as the abdomen. There are two species, viz. T. fungorum, found on tree-fungi, in Germany; and T. ancora.

TETRODON, in natural history, a genus of fishes of the order Cartilaginei. Generic character: jaws bony, divided at the end; body roughened beneath; no ventral fins; aperture of the gills linear. These fishes are chiefly met with in the seas between the tropics, and imagined to subsist

principally on shell fish. They are distinguished by the faculty of inflating or compressing their bodies at pleasure, and continuing in either state for a considerable time. During inflation, the spines which are scattered over the lower part of the body are erected with great intensity. There are thirteen species. T. lagocephalus, or the hare tetrodon, is a foot long, very thick in front, but becoming perpetually more slender towards the tail. It is found in the American and Indian Seas, has been very rarely taken on the British coast, and possesses the power of swelling itself to a size truly astonishing.

T. ocellatus, is seven inches long, and particularly abounds about Japan and China. It is taken for food, but requires to be cleaned with particular accuracy, as certain parts of it are reported to be highly poisonous. On this account it is prohibited to the military of Japan; but by a singular and capricious distinction is still permitted to every other class of subjects.

For the tortoise-shell tetrodon, see Pisces, Plate VI. fig. 4.

TEUCRIUM, in botany, *germander*, so named from Teucer, son of Scamander, and father-in-law of Dardanus King of Troy, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: corolla, upper lip two-parted beyond the base, divaricating where the stamens are. There are sixty-nine species.

TEUTHIS, in natural history, a genus of fishes of the order Abdominales. Generic character: head truncated on the fore-part; gill membrane, with five rays; teeth equal, rigid, approximate, in a single row. There are two species. T. hepatus, has a recumbent moveable spine on each side the tail, and inhabits the seas of India and America.

T. Java, has an unarmed tail, lunated, and its body is marked with longitudinal black spots.

TEUTONIC *order*, a military order of knights, established towards the close of the twelfth century, and thus called as consisting chiefly of Germans or Teutons. The origin, &c. of the Teutonic order is said to be this. The Christians, under Guy of Lusignan, laying siege to Acre, or Acon, a city of Syria, on the borders of the Holy Land, some Germans of Bremen and Lubec, touched with compassion for the sick and wounded of the army, who wanted common necessaries, set on foot a kind of hospital under a tent, which they made of a ship's sail, and here betook themselves to a charitable attendance on them. This started a thought of establishing a third military order, in imitation of the Templars and Hospitallers. The design was approved of by the patriarch of Jerusalem, the archbishops and bishops of the neighbouring places, the King of Jerusalem, the masters of the temple and hospital, and the German lords and prelates then in the Holy Land, and Pope Calixtus III. confirmed it by his bull, and the new order was called the order of Teutonic Knights of the House of St. Mary at Jerusalem. The Pope granted them all the privileges of the Templars and Hospitallers of St. John, excepting that they were to be subject to the patriarchs and other prelates, and that they should pay tythe of what they possessed.

TEXT, a relative term, contradistinguished to gloss or commentary, and signifying an original discourse exclusive of any note or interpretation. This word is particularly used for a certain passage of scripture, chosen by a preacher to be the subject of his sermon.

A text-book, in several universities, is a classic author written very wide by the students, to give room for an interpretation dictated by the master or regent to be inserted in the interlines. The Spaniards give the name of text to a kind of little poem, or set of verses, placed at the head of a gloss, and making the subject thereof, each verse being explained one after another in the course of the gloss.

THALES, in biography, a celebrated Greek philosopher, and the first of the wise men of Greece, born at Miletum about 640 years before the Christian æra. When he had acquired the usual learning of his country, he travelled into Asia and Egypt, to be instructed in geometry, astronomy, and natural philosophy. On his return he became a teacher of youth, and among his disciples, which were numerous, were Anaximander, Anaximenes, and Pythagoras. Thales was the author of the Ionian sect of philosophers; he was reckoned, by the best historians, the father of Greek philosophy, being the first that made any researches into natural knowledge and mathematics. He thought water was the principle of which all bodies in the universe are composed: that the world was the work of God, whom he regarded as omniscient, and beholding the secret thoughts in the heart of man. He maintained that real happiness consisted in health and knowledge: that the most ancient of beings

is God, because he is uncreated: that nothing is more beautiful than the world, because it is the work of God; nothing more extensive than space, quicker than spirit, stronger than necessity, wiser than time. He used to observe, that we ought never to say that to any one which may be turned to our prejudice: and that we should live with our friends as with persons that may become our enemies. In geometry he was a considerable inventor, as well as an improver, particularly in triangles; and all the writers agree, that he was the first, even in Egypt, who took the height of the pyramids by the shadow. His knowledge and improvements in astronomy were very considerable. He divided the celestial sphere into five circles or zones; the arctic and antarctic circles, the two tropical circles, and the equator. He observed the apparent diameter of the sun, which he made equal to half a degree; and formed the constellation of the Little Bear. He observed the nature and course of eclipses, and calculated them exactly; one in particular, memorably recorded by Herodotus, as it happened on a day of battle between the Medes and Lydians, which Thales had foretold; and he divided the year into 365 days. He died at the age of ninety years, leaving behind him an excellent character, as a mathematician, a philosopher, and moralist.

THALIA, in botany, so named in memory of John Thalius, a physician at Nordhuys, a genus of the Monandria Monogynia class and order. Natural order of Scitamineæ. Cannæ, Jussieu. Essential character: calyx three leaved; corolla five-petalled, two inner petals less; nectary lanceolate, concave; drupe with a one-celled nut. There are two species, *viz.* T. geniculata, and T. cannæformis; the former is a native of South America, the latter of Mallicollo, one of the New Hebrides, in Australasia; it was also found in the Andaman Isles, and Rangoon, in the kingdom of Pegue, by Dr. Buchanan.

THALICTRUM, in botany, *meadow rue*, a genus of the Polyandria Polygynia class and order. Natural order of Multisilique. Ranunculaceæ, Jussieu. Essential character: calyx none; petals four or five; seeds tailless. There are twenty-two species.

THALLITE, in mineralogy, a stone found in the fissures of mountains in Dauphiny, and on Chamouni, in the Alps. It is sometimes amorphous, and sometimes chrystallised. It is brittle. Specific gravity about 3.4. Before the blow-pipe it froths, and melts into a black slag: with borax it melts into a green bead. The constituent parts are,

Silica	37.0
Alumina	27.0
Oxide of Iron	17.0
Lime	14.0
Oxide of manganese	1.5
	96.5
Loss	3.5
	100.0

THAPSIA, in botany, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ, or Umbelliferæ. Essential character: fruit oblong, surrounded by a membrane. There are six species.

THEA, in botany, *tea-tree*, a genus of the Polyandria Monogynia class and order. Natural order of Columniferæ. Aurantia, Jussieu. Essential character: corolla six or nine-petalled; calyx five or six-leaved; capsule tricoccous.

The tea plant is a native of Japan, China, and Tonquin, and has not been found growing spontaneously in any other part of the world.

Linnæus says that there are two species of the tea plant; the bohea, the corolla of which has six petals; and the viridis, or green tea, which has nine petals. Thunberg makes only one species, the bohea, consisting of two varieties: the one with broad and the other with narrow leaves. This botanist's authority is decisive respecting the Japanese tea plants; but as China has not yet been explored, we cannot determine what number of species there are in that country. The tea-tree, however, is now common in the botanical gardens in this country; and it is evident that there are two species, or, at least, permanent varieties of it: one with a much longer leaf than the other, which our gardeners call the green tea; and the other with shorter leaves, which they call the bohea. The green is by much the hardiest plant, and with very little protection will bear the rigour of our winters.

This plant delights in valleys, and is frequent on the sloping sides of mountains and the banks of rivers, where it enjoys a southern exposure. It flourishes in the northern latitudes of Pekin as well as round Canton; but attains the greatest pefection in the mild temperate regions of Nankin. It is said only to be found between the 30th

and 45th degree of north latitude. In Japan it is planted round the borders of fields, without regard to the soil; but as it is an important article of commerce with the Chinese, whose fields are covered with it, it is by them cultivated with care. The Abbé Rochon says, it grows equally well in a poor as in a rich soil; but that there are certain places where it is of a better quality. The tea which grows in rocky ground is superior to that which grows in a light soil; and the worst kind is that which is produced in a clay soil. It is propagated by seeds; from six to twelve are put into a hole about five inches deep, at certain distances from each other. The reason why so many seeds are sown in the same hole is said to be, that only a fifth part vegetate. Being thus sown, they grow without any other care. Some, however, manure the land, and remove the weeds; for the Chinese are as fond of good tea, and take as much pains to procure it of an excellent quality, as the Europeans do to procure excellent wine.

The leaves are not fit for being plucked till the shrub is of three years' growth. In seven years it rises to a man's height; but as it then bears but few leaves, it is cut down to the stem, and this produces a new crop of fresh shoots the following summer, every one of which bears nearly as many leaves as a whole shrub. Sometimes the plants are not cut down till they are ten years old. We are informed, by Kæmpfer, that there are three seasons in which the leaves are collected in the isles of Japan, from which the tea derives different degrees of perfection.

The first gathering commences at the end of February or beginning of March. The leaves are then small, tender, and unfolded, and not above three or four days old: it is called imperial tea, being generally reserved for the court and people of rank; and sometimes also it is named bloom tea. It is sold in China for 20*d.* or 2*s.* per pound. The labourers employed in collecting it do not pull the leaves by handfuls, but pick them up one by one, and take every precaution that they may not break them. However long and tedious this labour may appear, they gather from four to ten or fifteen pounds a day.

The second crop is gathered about the end of March or beginning of April. At this season part of their leaves have attained their full growth, and the rest are not above half their size. This difference does not, however, prevent them from being all gathered indiscriminately. They are afterwards picked and assorted into different parcels, according to their age and size. The youngest, which are carefully separated from the rest, are often sold for leaves of the first crops, or for imperial tea. Tea gathered at this season is called Chinese tea, because the people of Japan infuse it, and drink it after the Chinese manner.

The third crop is gathered in the end of May, or in the month of June. The leaves are then very numerous and thick, and have acquired their full growth. This kind of tea is the coarsest of all, and is reserved for the common people. Some of the Japanese collect their tea only at two seasons of the year, which correspond to the second and third already mentioned: others confine themselves to one general gathering of their crop, towards the month of June; however, they always form afterwards different assortments of their leaves.

In this country teas are generally divided into three kinds of green, and five of bohea: the former are, 1. Imperial, or bloom tea, with a large loose leaf, light green colour, and a faint delicate smell. 2. Hyson, so called from the name of the merchant who first imported it; the leaves of which are closely curled and small, of a green colour, verging to a blue. 3. Singlo tea, from the name of the place where it is cultivated. The boheas are, 1. Souchong, which imparts a yellow-green colour by infusion. 2. Camho, so called from the place where it is made; a fragrant tea, with a violet smell; its infusion pale. 3. Congo, which has a larger leaf than the preceding, and its infusion somewhat deeper, resembling common bohea in the colour of the leaf. 4. Pekoe tea; this is known by the appearance of small white flowers mixed with it. 5. Common bohea, whose leaves are of one colour. There are other varieties, particularly a kind of green tea, done up in roundish balls, called gunpowder tea.

THELYGONUM, in botany, a genus of the Monoecia Polyandria class and order. Natural order of Scabridæ. Urticæ, Jussieu. Essential character: male, calyx bifid; corolla none; stamina commonly twelve: female, calyx bifid; corolla none; pistil one; capsule coriaceous, one-celled, one-seeded. There is only one species, viz. T. cynocrambe, purslain-leaved thelygonum, or dog's cabbage: this is an annual plant, decaying as soon as the seeds ripen; the stalks trail on the ground like those of chick-weed; they grow about a foot in

length, having acute pointed leaves, on long bordered foot-stalks; flowers axillary, in clusters, sitting very close, small, and of an herbaceous white colour; male and female from the same joint; it is a native of the South of France, near Montpelier.

THEOBROMA, in botany, a genus of the Polyadelphia Decandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character: calyx five-leaved; petals five, arched; nectuary five-horned; filaments five, within the calyx of the petals, growing externally to the nectary, having two anthers on each. There is but one species, *viz.* T. cacao, chocolate nut tree, which grows in a very handsome form, to the height of twelve or sixteen feet; the wood is light, and of a white colour; the bark is brownish and even; leaves lanceolate, oblong, bright green, entire, from nine to sixteen inches long, and from three to four in the widest part, on a petiole an inch in length, thickened at both ends; peduncles slender, eight or ten together, chiefly from the scars of fallen leaves; flowers small, reddish, inodorous; fruit smooth, yellow and red, about three inches in diameter; rind fleshy, half an inch in thickness; pulp whitish, the consistence of butter, separating from the rind in a state of ripeness, and adhering to it only by filaments, which penetrate it and reach to the seeds; when the seeds are ripe, it is known by the rattling of the capsule when shaken. This tree bears leaves, flowers, and fruit, all the year through; the usual seasons for gathering the fruit are June and December; one tree yields two to three pounds of seeds annually. It is a native of South America; it is also found in several places between the Tropics, particularly at Caracca and Carthagena, on the river Amazons, the Isthmus of Darien, &c. This tree is cultivated in many of the West India islands, belonging to the French and Spaniards, and formerly in some of those belonging to the English, but has been neglected in the latter for many years past.

THEODOLITE, a mathematical instrument much used in surveying, for the taking of angles, distances, &c. It is made variously, several persons having their several ways of contriving it, each more simple and portable, more accurate and expeditious than others. The common one consists of a brass circle about a foot diameter, having its limb divided into 360 degrees, and each degree subdivided, either diagonally, or otherwise, into minutes. See Level.

THEODOSIUS, in biography, a celebrated mathematician, who flourished in the times of Cicero and Pompey; but the time and place of his death are unknown. He chiefly cultivated that part of geometry which relates to the doctrine of the sphere, concerning which he published three books. The first of these contains twenty-two propositions; the second twenty-three; and the third fourteen; all demonstrated in the pure geometrical manner of the ancients. Ptolemy made great use of these propositions, as well as all succeeding writers. These books were translated by the Arabians, out of the original Greek, into their own language. From the Arabic, the work was again translated into Latin, and printed at Venice. But the Arabic version being very defective, a more complete edition was published in Greek and Latin, at Paris, 1558. And Vitello acquired reputation by translating Theodosius into Latin. This author's works were also commented on and illustrated by Clavius, and others; but the edition of Theodosius's Spherics which is now most in use, was translated, and published, by our countryman, the learned Dr. Barrow, in the year 1675, illustrated and demonstrated in a new and concise method. By this author's account, Theodosius appears not only to be a great master in this more difficult part of geometry, but the first considerable author of antiquity who has written on that subject.

THEOPHRASTA, in botany, so named in honour of the celebrated Grecian philosopher and botanist Theophrastus Eresius, a genus of the Pentandria Monogynia class and order. Natural order of Apocineæ, Jussieu. Essential character: corolla bell-shaped, with oblong erect spreading segments; fruit one-celled, very large, roundish, many-seeded. There are two species, *viz.* T. americana and T. longifolia, both natives of America.

THEOREM, a speculative proposition, demonstrating the properties of any subject. Theorems are either universal, which extend to any quantity, without restriction universally; as this, that the rectangle of the sum, and difference of any two quantities, is equal to the difference of their squares; or particular, which extend only to a particular quantity; as this, in an equilateral right-lined triangle, each of the angles is 60 degrees. Theorems are again

distinguished into negative, local, plane, and solid. A negative theorem is that which expresses the impossibility of any assertion; as that the sum of two biquadrate numbers cannot make a square number. A local theorem is that which relates to a surface; as, that the triangles of the same base and altitude are equal. A plane theorem is that which either relates to a rectilinear surface, or to one terminated by the circumference of a circle; as that all angles in the same segment of a circle are equal. And a solid theorem is that which considers a space terminated by a solid line; that is, by any of the three conic sections, *e. gr.* this; that if a right line cut two asymptotic parabolas, its two parts terminated by them shall be equal.

THEORY, in general, denotes any doctrine which terminates in speculation alone, without considering the practical uses and application thereof.

THERMOMETER, an instrument for measuring the degree of heat or cold in any body. The first form of this instrument for measuring the degrees of heat and cold, was the air thermometer. It is a well known fact that air expands with heat so as to occupy more space than it does when cold, and that it is condensed by cold so as to occupy less space than when warmed, and that this expansion and condensation is greater or less according to the degree of heat or cold applied. The principle then on which the air-thermometer was constructed is very simple. The air was confined in a tube by means of some coloured liquor; the liquor rose or fell according as the air became expanded or condensed. What the first form of the tube was, cannot now perhaps be well known; but the following description of the air-thermometer will fully explain its nature. It consists of a glass tube, B E, (Plate Miscel. XVI. fig. 4.) connected at one end with a large glass ball, A, and at the other end immersed in an open vessel, or terminating in a ball, D E, with a narrow orifice at D; which vessel or ball contains any coloured liquor that will not easily freeze. Aquafortis tinged of a fine blue colour with a solution of vitriol or copper, or spirit of wine tinged with cochineal, will answer this purpose. But the ball, A, must be first moderately warmed, so that a part of the air contained in it may be expelled through the orifice, D; and then the liquor pressed by the weight of the atmosphere will enter the ball, D E, and rise, for example, to the middle of the tube at C, at a mean temperature of the weather; and in this state the liquor by its weight, and the air included in the ball, A, &c. by its elasticity, will counterbalance the weight of the atmosphere. As the surrounding air becomes warmer, the air in the ball and upper part of the tube, expanding by heat, will drive the liquor into the lower ball, and consequently its surface will descend; on the contrary, as the ambient air becomes colder, that in the ball is condensed, and the liquor pressed by the weight of the atmosphere will ascend; so that the liquor in the tube will ascend or descend more or less according to the state of the air contiguous to the instrument. To the tube is affixed a scale of the same length, divided upwards and downwards from the middle, C, into 100 equal parts, by means of which the ascent and descent of the liquor in the tube, and consequently the variations in the cold or heat of the atmosphere, may be observed.

The air being found improper for measuring with accuracy the variations of heat and cold according to the form of the thermometer which was first adopted, another fluid was proposed about the middle of the seventeenth century by the Florentine Academy. This fluid was spirit of wine, or alcohol, as it is now generally named. The alcohol being coloured, was inclosed in a very fine cylindrical glass tube previously exhausted of its air, having a hollow ball at one end, A, (fig. 5.) and hermetically sealed at the other end, D. The ball and tube are filled with rectified spirit of wine to a convenient height, as to C, when the weather is of a mean temperature, which may be done by inverting the tube into a vessel of stagnant coloured spirit, under a receiver of the air-pump, or in any other way. When the thermometer is properly filled, the end D is heated red hot by a lamp, and then hermetically sealed, leaving the included air of about one-third of its natural density, to prevent the air which is in the spirit from dividing it in its expansion. To the tube is applied a scale, divided from the middle, into 100 equal parts, upwards and downwards. As spirit of wine is capable of a very considerable degree of rarefaction and condensation by heat and cold, when the heat of the atmosphere increases the spirit dilates, and consequently rises in the tube; and when the heat decreases, the spirit descends, and the degree or quantity of the motion is shown by a scale.

This was evidently an improvement on

the air-thermometer, but was itself not free from objections. The liquor could not easily be obtained of the same strength, and hence different tubes filled with it, when exposed to the same degree of heat, would not correspond. Another defect was the want of some fixed guide as a standard to commence the graduation. Philosophers soon saw that some fixed and unalterable point must be found, by which all thermometers might be accurately adjusted. Dr. Halley proposed that thermometers should be graduated in a deep pit, where the temperature in all seasons was nearly the same. This however could not generally be practised. He thought of the boiling point of water, of mercury, and of spirit of wine, preferring the latter, on account of the freezing of water, not knowing that this was fixed and uniform. At length Sir Isaac Newton determined this important point, on which the accuracy and value of the thermometer depends. He chose, as fixed, those points at which water freezes and boils, the very points which the experiments of succeeding philosophers have determined to be the most fixed and convenient. Sensible of the disadvantages of spirit of wine, he tried another liquor which was homogeneous enough, and capable of a considerable rarefaction, several times greater than spirit of wine. This was linseed oil. It has not been observed to freeze even in very great colds, and it bears a heat very much greater than water before it boils. With these advantages it was made use of by Sir Isaac Newton, who discovered by it the comparative degree of heat for boiling water, melting wax, boiling spirit of wine, and melting tin; beyond which it does not appear that this thermometer was applied. The method he used for adjusting the scale of this oil-thermometer was as follows: supposing the bulb, when immerged in thawing snow, to contain 10,000 parts, he found the oil expand by the heat of the human body so as to take up one thirty-ninth more space, or 10,256 such parts; and by the heat of water boiling strongly 10,725; and by the heat of melting tin 11,516. So that reckoning the freezing point as a common limit between heat and cold, he began his scale there, marking it 0, and the heat of the human body he made 12°, and consequently, the degrees of heat being proportional to the degrees of rarefaction, or 256 . 725 : : 12 : 34, this number 34 will express the heat of boiling water, and by the same rule, 72 that of melting tin. This thermometer was constructed in 1701. To the application of oil as a measure of heat and cold, there are insuperable objections. It is so viscid, that it adheres too strongly to the sides of the tube. On this account it ascends and descends too slowly in case of a sudden heat or cold. In a sudden cold, so great a portion remains adhering to the sides of the tube after the rest has subsided, that the surface appears lower than the corresponding temperature of the air requires. An oil thermometer is therefore not a proper measure of heat and cold. All the thermometers hitherto proposed were liable to many inconveniences, and could not be considered as exact standards for pointing out the various degrees of temperature. This led Reaumur to attempt a new one, an account of which was published in the year 1730 in the Memoirs of the Academy of Sciences. This thermometer was made with spirit of wine. He took a large ball and tube, the dimensions and capacities of which were known; he then graduated the tube, so that the space from one division to another might contain 1,000th part of the liquor; the liquor containing 1,000 parts when it stood at the freezing point. He adjusted the thermometer to the freezing point by an artificial congelation of water, then putting the ball of his thermometer and part of the tube into boiling water, he observed whether it rose 80 divisions; if it exceeded these, he changed his liquor, and by adding water lowered it, till upon trial it should just rise 80 divisions, or if the liquor, being too low, fell short of 80 divisions, he raised it by adding rectified spirit to it. The liquor thus prepared suited his purpose, and served for making a thermometer of any size, whose scale would agree with his standard. At length a different fluid was proposed, by which thermometers could be made free from most of the defects hitherto mentioned. This fluid was mercury, and seems first to have occurred to Dr. Halley, but was not adopted by him on account of its having a smaller degree of expansibility than the other fluids used at that time.

The honour of this invention is generally given to Fahrenheit of Amsterdam, who presented an account of it to the Royal Society of London in 1724. That we may judge the more accurately of the propriety of employing mercury, we will compare its qualities with those of the fluids already mentioned, air, alcohol, and oil. Air is the most expansible fluid, but it does not receive nor part with

its heat so quickly as mercury. Alcohol does not expand much by heat. In its ordinary state it does not bear a much greater heat than 175° of Fahrenheit; but when highly rectified it can bear a greater degree of cold than any other liquor hitherto employed as a measure of temperature. At Hudson's Bay, Mr. Macnab, by a mixture of vitriolic acid and snow, made it to descend to 69° below 0 of Fahrenheit. There is an inconvenience, however, attending the use of this liquor; it is not possible to get it always of the same degree of strength. As to oil, its expansion is about 15 times greater than that of alcohol; it sustains a heat of 600°, and its freezing point is so low that it has not been determined; but its viscosity renders it useless.

Mercury is far superior to alcohol and oil, and is much more manageable than air. 1. As far as the experiments already made can determine, it is of all the fluids hitherto employed in the construction of thermometers, that which measures most exactly equal differences of heat by equal differences of its bulk: its dilatations are, in fact, very nearly proportional to the augmentations of heat applied to it. 2. Of all liquids it is the most easily freed from air. 3. It is fitted to measure high degrees of heat and cold. It sustains a heat of 600° of Fahrenheit's scale, and does not congeal till it fall 39 or 40 degrees below 0. 4. It is the most sensible of any fluid to heat and cold, even air not excepted. Count Rumford found, that mercury was heated from the freezing to the boiling point in 58 seconds, while water took 2 minutes 13 seconds, and common air 10 minutes and 17 seconds. 5. Mercury is a homogeneous fluid, and every portion of it is equally dilated or contracted by equal variations of heat. Any one thermometer, made of pure mercury, is *cæteris paribus*, possessed of the same properties with every other thermometer made of pure mercury. Its power of expansion is indeed about six times less than that of spirit of wine, but it is great enough to answer most of the purposes for which a thermometer is wanted. The fixed points, which are now universally chosen for adjusting thermometers to a scale, and to one another, are the boiling and freezing water points. The boiling water point, it is well known, is not an invariable point, but varies some degrees according to the weight and temperature of the atmosphere. In an exhausted receiver, water will boil with a heat of 98° or 100°; whereas, in Papin's digester, it will acquire a heat of 412°. Hence it appears, that water will boil at a lower point, according to its height in the atmosphere, or to the weight of the column of air which presses upon it. In order to ensure uniformity, therefore, in the construction of thermometers, it is now agreed, that the bulb of the tube be plunged in the water when it boils violently, the barometer standing at 30 English inches, and the temperature of the atmosphere 55°. A thermometer made in this way, with its boiling point at 212°, is called, by Dr. Horsley, "Bird's Fahrenheit," because Mr. Bird was the first person who attended to the state of the barometer in constructing thermometers.

As artists may be often obliged to adjust thermometers under very different pressures of the atmosphere, philosophers have been at pains to discover a general rule which might be applied on all occasions. M. de Luc, from a series of experiments, has given an equation for the allowance on account of this difference, in Paris measure, which has been verified by Sir George Schuckburg; also Dr. Horsley, Dr. Maskelyne, and Sir George Schuckburgh, have adapted the equation and rules to English measures, and have reduced the allowances into tables, for the use of the artist. Dr. Horsley's rule, deduced from De Luc's, is this:

$$\frac{99}{8990000} \log. z - 92.804 = h.$$

Where h denotes the height of a thermometer plunged in boiling water above the point of melting ice, in degrees of Bird's Fahrenheit, and z the height of the barometer in 10ths of an inch. From this rule he has computed the following table, for finding the heights to which a good Bird's Fahrenheit will rise, when plunged in boiling water, in all states of the barometer, from 27 to 31 English inches; which will serve, among other uses, to direct instrument-makers in making a true allowance for the effect of the variation of the barometer, if they should be obliged to finish a thermometer at a time when the barometer is above or below 30 inches; though it is best to fix the boiling point when the barometer is at that height.

EQUATION OF THE BOILING POINT.

Barometer.	Equation.	Difference.
31.0	+ 1.57	0.78
30.5	+ 0.79	0.79
30.0	0.00	0.80
29.5	— 0.80	0.82
29.0	— 1.62	0.83
28.5	— 2.45	0.85
28.0	— 3.31	0.86
27.5	— 4.16	0.88
27.0	— 5.04	

The numbers in the first column of this table express heights of the quicksilver in the barometer, in English inches and decimal parts: the second column shows the equation to be applied, according to the sign prefixed, to 212° of Bird's Fahrenheit, to find the true boiling point for every such state of the barometer. The boiling point, for all intermediate states of the barometer, may be had, with sufficient accuracy, by taking proportional parts, by means of the third column of differences of the equations.

The method of constructing Fahrenheit's thermometer, which is now in general use in this country, is the following: a small ball is blown on the end of a glass tube, of an uniform width throughout. The ball and part of the tube are then to be filled with quicksilver, which has been previously boiled to expel the air. The open end of the tube is then to be hermetically sealed. The next object is to construct the scale. It is found, by experiment, that melting snow, or freezing water, is always at the same temperature. If, therefore, a thermometer be immersed in the one or the other, the quicksilver will always stand at the same point. It has been observed, too, that water boils under the same pressure of the atmosphere at the same temperature. A thermometer, therefore, immersed in boiling water, will uniformly stand at the same point. Here, then, are two fixed points, from which a scale may be constructed, by dividing the intermediate space into equal parts, and carrying the same divisions as far above and below the two fixed points as may be wanted. Thus, thermometers constructed in this way may be compared together; for if they are accurately made, and placed in the same temperature, they will always point to the same degree on the scale. The fluid, as we have seen, employed is quicksilver, and it is found to answer best, because its expansions are most equable. The freezing point of Fahrenheit's thermometer is marked 32°, and the reason of this is said to have been, that this artist thought that he had produced the greatest degree of cold, by a mixture of snow and salt; and the point at which the thermometer then stood, in this temperature, was marked Zero. The boiling point, in this thermometer, is 212°, and the intermediate space, between the boiling and freezing points, is therefore divided into 180°. This is the thermometer that is commonly used in Britain.

There are three other thermometers employed in different countries of Europe, which differ from each other in the number of degrees between the freezing and boiling points. Reaumur's thermometer was generally used in France before the revolution, and is still employed in different countries on the Continent. The freezing point, in this thermometer, is marked Zero, and the boiling point 80°. To convert the degrees of Reaumur's thermometer to those of Fahrenheit, the following is the formula. Reaum. $\frac{\times 9}{4} + 32 =$ Fahr. that is, multiply the degrees of Reaumur by 9, divide by 4, and add 32. This gives the corresponding degress on Fahrenheit's scale. The thermometer of Celsus has the space between the freezing and boiling points divided into 100°. The boiling point is 100°, and the freezing point Zero. This thermometer is used in Sweden. The "thermometre centigrade," now used in France, has the scale divided in the same way. To convert the degrees of this thermometer into those of Fahrenheit; Cel. $\frac{\times 9}{5} + 32 =$ Fahr. In Delisle's thermometer, which is used in Russia, the space between the boiling and freezing points is divided into 150°; but the degrees are reckoned downwards. The boiling point is marked Zero, and the freezing point 150°. To reduce the degrees of this thermometer under the boiling point to those of Fahrenheit; Del. $\frac{\times 6}{5} - 212 =$ Fahr. And above the boiling point. Del. $\frac{\times 6}{5} + 212 =$ Fahr.

Such, then, are the principles and mode of construction of the thermometer; an instrument which has been of the utmost importance in enabling us to discover many of the properties and effects of caloric, as by it only we can ascertain, with accuracy, the relative temperatures.

In meteorological observations, it is necessary to attend to the greatest rise and

fall of the thermometer, and therefore attempts have been made to make them mark the greatest degree of heat and cold, in the absence of the observer. We will notice one, intended to show the greatest degree of heat. A B, fig. 6, is a glass tube, with a cylindrical bulb, B, at the lower end, and capillary at the other, over which there is a fixed glass ball, C. The bulb, and part of the tube, are filled with mercury, the top of which shows the degrees of heat. The upper part of the tube, above the mercury, is filled with spirit of wine; the ball, C, is likewise filled with the same liquor, almost to the top of the capillary tube. When the mercury rises, the spirit of wine is also raised into the ball, C, which is so made that the liquor cannot return into the tube when the mercury sinks; of course, the height of the spirit in the ball, added to that in the tube, will give the greatest degree of heat. To make a new observation, the instrument must be inclined till the liquor in the ball cover the end of the capillary tube.

In 1782, Mr. Six proposed another self-registering thermometer. It is properly a spirit of wine thermometer, though mercury is also employed for supporting an index: *ab* (fig. 7) is a thin tube of glass sixteen inches long, and five-sixteenths of an inch calibre: *cde*, and *fgh*, are smaller tubes, about one-twentieth of an inch calibre. These three tubes are filled with highly rectified spirit of wine, except the space between *d* and *g*, which is filled with mercury. As the spirit of wine contracts or expands in the middle tube, the mercury falls or rises in the outside tubes. An index, such as that represented in fig. 8, is placed on the surface, within each of these tubes, so light as to float upon it: *k* is a small glass tube, three-fourths of an inch long, hermetically sealed at each end, and inclosing a piece of steel wire nearly of its own length. At each end, *l m*, of this small tube, a short tube of black glass is fixed, of such a diameter as to pass freely up and down within either of the outside tubes of the thermometer, *ce*, or *fh*. From the upper end of the index is drawn a spring of glass to the fineness of a hair, and about five-sevenths of an inch long; which, being placed a little oblique, presses lightly against the inner surface of the tube, and prevents the index from descending when the mercury descends. These indexes being inserted one into each of the outside tubes, it is easy to understand how they point out the greatest heat or cold that has happened in the observer's absence. When the spirit of wine in the middle tube expands, it presses down the mercury in the tube, *hf*, and consequently raises it in the tube, *eo*; consequently, the index on the left hand tube is left behind, and marks the greatest cold, and the index in the right hand tube rises, and marks the greatest heat.

The common contrivance for a self-registering thermometer, now sold in most of the London shops, consists simply of two thermometers, one mercurial, and the other of alcohol, (fig. 9) having their stems horizontal; the former has for its index a small bit of magnetical steel wire, and the latter a minute thread of glass, having its two ends formed into small knobs, by fusion in the flame of a candle.

The magnetical bit of wire lies in the vacant space of the mercurial thermometer, and is pushed forward by the mercury whenever the temperature rises, and pushes that fluid against it; but when the temperature falls, and the fluid retires, this index is left behind, and consequently shows the maximum. The other index, or bit of glass, lies in the tube of the spirit thermometer immersed in the alcohol: and when the spirit retires, by depression of temperature, the index is carried along with it, in apparent contact with its interior surface; but, on increase of temperature, the spirit goes forward and leaves the index, which therefore shows the minimum of temperature since it was set. As these indexes merely lie in the tubes, their resistance to motion is altogether inconsiderable. The steel index is brought to the mercury by applying a magnet on the outside of the tube, and the other is duly placed at the end of the column of alcohol, by inclining the whole instrument.

THERMOSCOPE, an instrument showing the changes happening in the air with respect to heat and cold. The word thermoscope is generally used indifferently with that of thermometer, though there is some difference in the literal import of the two; the first signifying an instrument that shows, or exhibits, the changes of heat, &c. to the eye; and the latter, an instrument that measures those changes; on which foundation the thermometer should be a more accurate thermoscope, &c.

THESIS, a general position which a person advances, and offers to maintain. In colleges it is frequent to have placards, con-

taining a number of them, in theology, in medicine, in philosophy, in law, &c.

THESIUM, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Vepreculæ. Elæagni, Jussieu. Essential character: calyx one-leaved, into which the stamens are inserted; nut inferior, one-seeded. There are nineteen species, almost all of which are found at the Cape of Good Hope.

THIMBLE, an instrument made of brass, silver, iron, &c. put on the finger to thrust a needle through any cloth, silk, &c. used by all seamstresses, tailors, &c. The common thimbles are generally made of shruff and old hammered brass. This they melt, and cast into a sort of sand, with which and red ochre are made moulds and cores. They are cast in double rows, and, when cold, taken out, and cut off with greasy shears. Then the cores being taken out, they are put into a barrel, as they do shot, and turned round with a horse till they rub the sand one from another: from thence they are carried to the mill to be turned first on the inside, and afterwards on the outside: then some saw-dust, or filings of horn combs, are put half-way into each thimble, and upon it an iron punch; and then with one blow against a studded steed the hollow of the bottom is made: after this, with an engine, the sides have the hollow made; this done, they are again polished on the inside; then the rim is turned at one stroke; and lastly, they are turned in a barrel with saw-dust, or bran, to scour them very bright.

THIMBLE, in naval affairs, a sort of iron ring, the outer surface of which is hollow throughout its whole circumference, in order to contain in the channel or cavity a rope which is spliced about it, and by which it may be hung in any particular situation. Its use is to defend the eye of the rope which surrounds it from being injured by another rope which passes through it, or by the hook of a tackle which is hung upon it.

THIRPS, in natural history, a genus of insect of the order of Hemiptera: snout obsolete, secreted within the mouth; antennæ filiform, as long as the thorax; body linear; abdomen bent upwards; four wings straight, incumbent; narrower than the body, and slightly crossed. There are eight species. T. physapus is accurately described in the Linnæan Transactions: it is found frequently in composite flowers, and in the spikes of wheat and rye, to which it is said to be exceedingly destructive, though others deny the fact. It may be often seen in the flowers of the dandelion: it wanders from petal to petal, descending to the bottom of the florets, occasionally emerging at intervals, and often skipping from place to place: in performing this action, it is observed suddenly to turn back its abdomen, so as nearly to touch the thorax with its tip. The larva, in some respects, resembles the complete insect: it is however yellow, and six-footed: the antennæ and head black and white, pupa whitish, with black eyes.

THISTLE, *carduus*, in botany. See CARDUUS.

THISTLE, *order of the*, or *of St.* ANDREW, a military order of knighthood in Scotland, the rise and institution whereof is variously related by different authors: Lesley, Bishop of Ross, reports, that the night before the battle between Athelstan King of Northumberland, and Hungus King of the Picts, a bright cross, in form of that whereon St. Andrew (the tutelar saint of Scotland) suffered martyrdom, appeared to Hungus, who, having gained the victory, ever after bore the figure of that cross on his banners. Others assert, that Achains King of Scotland first instituted this order, after having made the famous league, offensive and defensive, with Charlemagne King of France. But although the thistle had been acknowledged as the symbol of the kingdom of Scotland, from the reign of Achains, yet some refer the beginning of this order to the reign of Charles VII. of France. Others place the foundation of it as low as the year 1500.

The chief and principal ensign is a gold collar, composed of thistles and sprigs of rue interlinked with amulets of gold, having pendent thereto the image of St. Andrew with his cross, and the motto, NEMO ME IMPUNE LACESSET.

The ordinary or common ensign worn by the knights, is a star of four silver points and over them a green circle, bordered and lettered with gold, containing the said motto, and in the centre is a thistle proper; all which is embroidered on their left breast, and worn with the collar, with a green ribband over the left shoulder, and brought under the right arm; pendent thereto is the image of St. Andrew, with his cross, in a purple robe, within an oval of gold enamelled vert, with the former motto: but sometimes they wear, encircled in the same manner, a thistle crowned.

About the time of the reformation, this order was dropped, till James II. of Eng-

land resumed it, by creating eight knights: however, the revolution unsettled it again, and it lay neglected till queen Anne, in 1703, restored it to the primitive design, of twelve knights of St. Andrew. King George I. in the first of his reign, confirmed the statutes signed by queen Anne, with the addition of several more, among which was that of adding rays of glory to surround the figure of St. Andrew, which hangs at the collar: and though from the reformation to George I. both elections and instalments had been dispensed with, his majesty ordered that chapters of election should, for the future, be held in the royal presence; to which end he ordered the great wardrobe to provide the knights brethren, and officers, with such mantles as the statutes of the said order appointed.

THLASPI, in botany, *bastard-cress*, a genus of the Tetradynamia Siliculosa class and order. Natural order of Siliquosæ or Cruciformes. Cruciferæ, Jussieu. Essential character: silicle emarginate, obcordate, many-seeded; valves boat-shaped, margined and keeled. There are fourteen species.

THOA, in botany, a genus of the Monoecia Polyandria class and order. Natural order of Urticæ, Jussieu. Essential character: calyx and corolla none; male, stamens numerous, at the joints of the spike; female, germs two, at the base of the male spike, one on each side, sessile; stigma three or four cleft; seed in a brittle shell, covered with a bristly web. There is only one species, viz. T. urens.

THOLES, in marine affairs, small pins driven perpendicularly into the gunwale of a boat, and serving to retain the oars in that space which is called the row-lock; sometimes there is only one pin to each oar, as in boats navigated in the Mediterranean Sea: in that case the oar is retained upon the pin, by means of a strop, or of a cleat, with a hole through it, nailed on the side of the oar.

THOUINIA, in botany, so named in honour of Mons. André Thouin, fellow of the National Institute, and professor of Horticulture in the French Museum, a genus of the Pentandria Monogynia class and order. Natural order of Convolvuli, Jussieu. Essential character: corolla one-petalled, bell-shaped, inferior, hispid on the outside; style simple; drupe. There is but one species, viz. T. spectabilis, a native of Madagascar, where it was found by Commerson.

THONSCHIEFER, in mineralogy, slate, is divided into three sub-species: 1. The common argillaceous schistus, which is composed of silex, alumina, oxide of iron, and proportions of carbonated lime and magnesia: it is used for covering houses, and the strait-foliated bluish-grey varieties are employed as writing slates: the softer and more compact varieties are made into slate pencils. See SCHISTUS, also SLATE. 2. Hone slate, called by Kirwan novaculite: its colour is a greenish-grey, or smoke-grey, passing to olive and mountain-green: It occurs in mass, and has a glimmering lustre: its fracture in the great is slaty; in the small, splintery: its fragments are tabular. It is more or less translucent on the edges: it is moderately hard, and not very frangible. Specific gravity 2.7. It does not effervesce with acids, neither is it fusible by the blow-pipe without addition. It is cut into hones for sharpening the finer kinds of steel instruments. It is found in Bareith, Seifendorf in Saxony, in Bohemia, and the Levant; hence it is called Turkish hone: also in some parts of North Wales. 3. Black chalk: its colour is greyish or bluish black. It occurs in mass: the fragments are tabular or splintery. It stains the fingers, and gives a somewhat glossy-grey streak. It is meagre, but smooth to the touch; is soft, and very easily frangible. Before the blow-pipe, without addition, it acquires a thin varnish, but does not melt. It has been analysed, and found to consist of

Silica	64.00
Alumina	11.25
Carbon	11.00
Oxide of iron	2.75
Water	7.50
	96.50
Loss	3.50
	100.00

It is employed for drawing, and writing on paper and other materials. The best kinds come from Italy: it is found in Spain also, and in Isla in the Hebrides.

THORACIC, or THORACICI, a term applied to an order of fishes in the Linnæan system: the character of this order of fishes is, that they have bony gills, and ventral fins directly under the thorax. There are the following genera belonging to this order:

Centrogaster	Chætodon
Cepola	Coryphæna

Cottus	Pleuronectes
Echineis	Scarus
Gasterosteus	Sciæna
Gobius	Scomber
Labrus	Scorpœna
Lonchiurus	Sparus
Mullus	Trachychthys
Perca	Trigla.

THRASHING, or THRESHING, in agriculture, the art of beating the corn out of the ears. There are several ways of separating corn from the ear; the first by beating it with a flail, which is properly what is called thrashing. The other method, still practised in several countries, is to make mules, or horses, trample on it, backwards and forwards; this is properly what the ancients called tritura and trituratio. The Hebrews used oxen therein, and sometimes yoked four together for this purpose. Another way among the ancients was with a kind of sledge, made of boards joined together, and loaden with stones or iron, upon which a man was mounted, and the whole drawn over the corn by horses: this instrument was called traha or tribula. It is a rule among husbandmen, that the season for thrashing is as soon as the corn has sweated in the heap or mow. Thrashing machines are now much in use with the farmers on a large scale.

THREAD, a small line, made up of a number of fine fibres of any vegetable or animal substance, such as flax, cotton, or silk thread.

THREATENING *letter*. If any person shall send any letter threatening to accuse any other person of a crime punishable with death, transportation, pillory, or other infamous punishment, with a view to extort money from him, he shall be punished at the discretion of the court, with fine, imprisonment, pillory, whipping, or transportation: 30. G. II. c. 24. And if the writer of a threatening letter deliver it himself, and do not send it, he is guilty of felony under this act.

THRINAX, in botany, a genus of the Appendix Palmæ class and order. Natural order of Palms. Essential character: calyx six-toothed; corolla none; stigma funnel-form, oblique; berry one-seeded. There is only one species, viz. T. parviflora, palmeto royal, or palmeto-thatch, a native of Jamaica and Hispaniola.

THRUSH. See TURDUS.

THRYALLIS, in botany, a genus of the Decandria Monogynia class and order. Natural order of Tricoccæ. Acera, Jussieu. Essential character: calyx five-parted; petals five; capsule tricoccous. There is but one species, *viz.* T. brasiliensis, a little shrub, with round jointed branches; small yellow flowers; fruits tricoccous, or three-grained; it is a native of Brasil.

THUJA, in botany, *arbor vitæ*, a genus of the Monoecia Monadelphia class and order. Natural order of Coniferæ. Essential character: male, calyx scale of an ament; corolla none; stamina four; female, calyx of a strobile, with a two-flowered scale; corolla none; pistil one; nut one, girt with a membranaceous wing. There are four species. We shall notice the T. occidentalis, American, or common, arbor vitæ; this tree has a strong woody trunk, rising to the height of forty feet; the bark, while young, is smooth, and of a dark brown colour, but as the trees advance, the bark becomes cracked, and less smooth, the branches are produced irregularly on every side, standing almost horizontal, the young slender shoots frequently hang down; the young branches are flat, and the small leaves are placed over each other like the scales of fish; the flowers are produced from the side of the young branches, very near to the foot stalk; the males grow in oblong catkins, between these the females are collected in form of cones; when the former have shed their farina, they soon drop off, the latter are succeeded by oblong cones, or strobiles, having obtuse smooth scales, containing one or two oblong seeds.

THUMERSTONE, in mineralogy, a species of the flint genus: common colour is brown of various degrees of intensity: it is seldom found massive, often disseminated, but most freqnently crystallized. Specific gravity about 3.3. It melts easily before the blow-pipe, without addition, into a greenish, white, semi-transparent glass. The constituent parts are,

Silica	52.70
Alumina	25.79
Lime	9.39
Oxide of iron	8.63
—— of manganese	1.00
Loss	2.49
	100.00

It appears to be peculiar to the primitive mountains, is found in many parts of

the continent, also in our country in Cornwall.

THUNBERGIA, in botany, so named in honour of Charles Peter Thunberg, M. D. professor of botany in the university of Upsal, &c. &c. a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Acanthi, Jussieu. Essential character: calyx double; outer two-leaved; inner twelve-toothed; corolla bell-shaped; capsule beaked, two-celled. There are two species, viz. T. capensis, and T. fragrans.

THUNDER, the noise occasioned by the explosion of a flash of lightning passing through the air: or it is that noise which is excited by a sudden explosion of electrical clouds, which are therefore called thunder-clouds.

The rattling in the noise of thunder, which makes it seem as if it passed through arches, is probably owing to the sound being excited among clouds hanging over one another, and the agitated air passing irregularly between them.

The explosion, if high in the air, and remote from us, will do no mischief; but when near, it may, and has in a thousand instances, destroyed trees, animals, &c. This proximity, or small distance, may be estimated nearly by the interval of time between seeing the flash of lightning, and hearing the report of the thunder, estimating the distance after the rate of 1,142 feet per second of time, or 3⅖ seconds to the mile. Dr. Wallis observes, that commonly the difference between the two is about seven seconds, which, at the rate above mentioned, gives the distance almost two miles. But sometimes it comes in a second or two, which argues the explosion very near us, and even among us. And in such cases, the doctor assures us, he has sometimes foretold the mischiefs that happened.

Although in this country thunder may happen at any time of the year, yet the months of July and August are those in which it may almost certainly be expected. Its duration is of very uncertain continuance; sometimes only a few peals will be heard at any particular place during the whole season; at other times the storm will return at the interval of three or four days, for a month, six weeks, or even longer; not that we have violent thunder in this country directly vertical in any one place so frequently in any year, but in many seasons it will be perceptible that thunder clouds are formed in the neighbourhood, even at these short intervals. Hence it appears, that during this particular period there must be some natural cause operating for the production of this phenomenon, which does not take place at other times. This cannot be the mere heat of the weather, for we have often a long tract of hot weather without any thunder; and besides, though not common, thunder is sometimes heard in the winter also. As therefore the heat of the weather is common to the whole summer, whether there be thunder or not, we must look for the causes of it in those phenomena, whatever they are, which are peculiar to the months of July, August, and the beginning of September. Now it is generally observed, that from the month of April, an east or south-east wind generally takes place, and continues with little interruption till towards the end of June. At that time, sometimes sooner and sometimes later, a westerly wind takes place; but as the causes producing the east wind are not removed, the latter opposes the west wind with its whole force. At the place of meeting, there is naturally a most vehement pressure of the atmosphere, and friction of its parts against one another; a calm ensues, and the vapours brought by both winds begin to collect and form dark clouds, which can have little motion either way, because they are pressed almost equally on all sides. For the most part, however, the west wind prevails, and what little motion the clouds have is towards the east: whence the common remark in this country, that "thunder-clouds move against the wind." But this is by no means universally true: for if the west wind happens to be excited by any temporary cause before its natural period when it should take place, the east wind will very frequently get the better of it; and the clouds, even although thunder is produced, will move westward. Yet in either case the motion is so slow, that the most superficial observers cannot help taking notice of a considerable resistance in the atmosphere.

When lightning acts with extraordinary violence, and breaks or shatters any thing, it is called a thunderbolt, which the vulgar, to fit it for such effects, suppose to be a hard body, and even a stone. But that we need not to have recourse to a hard solid body to account for the effects commonly attributed to the thunderbolt, will be evident to any one, who considers those of gunpowder, and the several chemical ful-

minating powders, but more especially the astonishing powers of electricity, when only collected and employed by human art, and much more when directed and exercised in the course of nature.

When we consider the known effects of electrical explosions, and those produced by lightning, we shall be at no loss to account for the extraordinary operations vulgarly ascribed to thunderbolts. As stones and bricks struck by lightning are often found in a vitrified state, we may reasonably suppose, with Beccaria, that some stones in the earth, having been struck in this manner, gave occasion to the vulgar opinion of the thunderbolt.

Thunder-clouds are those clouds which are in a state fit for producing lightning and thunder. From Beccaria's exact and circumstantial account of the external appearances of thunder-clouds, the following particulars are extracted. The first appearance of a thunder storm, which usually happens when there is little or no wind, is one dense cloud, or more, increasing very fast in size, and rising into the higher regions of the air. The lower surface is black and nearly level; but the upper finely arched, and well defined. Many of these clouds often seem piled upon one another, all arched in the same manner; but they are continually uniting, swelling, and extending their arches. At the time of the rising of this cloud, the atmosphere is commonly full of a great many separate clouds, that are motionless, and of odd whimsical shapes. All these, upon the appearance of the thunder-cloud, draw towards it, and become more uniform in their shapes as they approach; till, coming very near the thunder-cloud, their limbs mutually stretch towards one another, and they immediately coalesce into one uniform mass. These he calls adscititious clouds, from their coming in to enlarge the size of the thunder-cloud. But sometimes the thunder-cloud will swell, and increase very fast, without the conjuction of any adscititious clouds; the vapours in the atmosphere forming themselves into clouds wherever it passes. Some of the adscititious clouds appear like white fringes, at the skirts of the thunder-cloud, or under the body of it, but they keep continually growing darker and darker, as they approach to unite with it. When the thunder-cloud is grown to a great size, its lower surface is often ragged, particular parts being detached towards the earth, but still connected with the rest. Sometimes the lower surface swells into various large protuberances bending uniformly downward; and sometimes one whole side of the cloud will have an inclination to the earth, and the extremity of it nearly touch the ground. When the eye is under the thunder-cloud, after it is grown larger, and well formed, it is seen to sink lower, and to darken prodigiously; at the same time that a number of small adscititious clouds (the origin of which can never be perceived) are seen in a rapid motion, driving about in very uncertain directions under it. While these clouds are agitated with the most rapid motions, the rain commonly falls in the greatest plenty, and if the agitation be exceedingly great, it commonly hails. While the thunder-cloud is swelling, and extending its branches over a large tract of country, the lightning is seen to dart from one part of it to another, and often to illuminate its whole mass. When the cloud has acquired a sufficient extent, the lightning strikes between the cloud and the earth, in two opposite places, the path of the lightning lying through the whole body of the cloud and its branches. The longer this lightning continues, the less dense does the cloud become, and the less dark its appearance; till at length it breaks in different places, and shows a clear sky. These thunder-clouds were sometimes in a positive as well as a negative state of electricity. The electricity continued longer of the same kind, in proportion as the thunder-cloud was simple and uniform in its direction: but when the lightning changed its place, there commonly happened a change in the electricity of the apparatus over which the clouds passed. It would change suddenly after a very violent flash of lightning, but the change would be gradual when the lightning was moderate, and the progress of the thunder-cloud slow. See Priestley's History of Electricity.

THYMBRA, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ or Labiatæ. Essential character: calyx sub-cylindrical, two-lipped, scored on each side with a villose line; style semibifid. There are three species.

THYMUS, in botany, *thyme*, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ or Labiatæ. Essential character: throat of the two-lipped calyx closed with villose hairs. There are twenty-two species.

THYNNUS, in natural history, a genus

of insects of the order Hymenoptera: mouth horny, with an incurved mandible, the jaw short and straight; lip longer than the jaw, membranaceous at the tip, and trifid, the middle division emarginate; tongue very short, involute; four feelers, equal, filiform; antennæ cylindrical, the first joint thicker. There are four species: three of New Holland, and one of Africa. Specimens of them all are to be found in Sir Joseph Banks's museum.

TIARELLA, in botany, a genus of the Decandria Digynia class and order. Natural order of Succulentæ. Saxifragæ, Jussieu. Essential character: calyx five-parted; corolla five-petalled, inserted into the calyx; petals entire; capsule one-celled, two-valved, with one valve larger. There are two species; *viz.* T. cordifolia, heart-leaved tiarella; and T. trifoliata, three-leaved tiarella, both natives of the northern parts of America and Asia.

TIDES, two periodical motions of the waters of the sea, called the flux and reflux, or the flow and ebb. The cause of the tides is the attraction of the sun and moon, but chiefly of the latter; the waters of the immense ocean, forgetful, as it were, of their natural quietus, move and roll in tides, obsequious to the strong attractive power of the moon, and weaker influence of the sun. See ASTRONOMY.

That the tides may have their full motion, the ocean in which they are produced ought to be extended from east to west 90°, or a quarter of a great circle of the earth, at least; because the places where the moon raises most, and most depresses the water, are at that distance from one another. Hence it appears, that it is only in the great oceans that such tides can be produced; and why, in the large Pacific ocean, they exceed those in the Atlantic ocean; hence also it is obvious, why the tides are not so great in the torrid zone, between Africa and America, where the ocean is narrower, as in the temperate zones on either side; and from this also, we may understand why the tides are so small in islands that are very far distant from the shores. It is manifest, that, in the Atlantic ocean, the water cannot rise on one shore but by descending on the other; so that, at the intermediate distant islands, it must continue at about a mean height between its elevation on the one and on the other shore. As the tides pass over shoals, and run through straights into bays of the sea, their motion becomes more various, and their height depends on a great many circumstances. The tide that is produced on the western coast of Europe corresponds to the theory above described: thus, it is high water on the coast of Spain, Portugal, and the West of Ireland, about the third hour after the moon has passed the meridian: from thence it flows into the adjacent channels, as it finds the easiest passage. One current from it, for example, runs up by the south of England, and another comes in by the north of Scotland: they take a considerable time to move all this way, and it is high water sooner in the places to which they first come; and it begins to fall at those places, while the two currents are yet going on to others that are further in their course. As they return, they are not able to raise a tide; because the water runs faster off than it returns, til by a new tide propagated from the ocean, the return of the current is stopped, and the water begins to rise again. The tide takes twelve hours to come from the ocean to London bridge, so that, when it is high water there, a new tide is already come to its height in the ocean; and, in some intermediate place, it must be low water at the same time. In channels, therefore, and narrow seas, the progress of the tides may be, in some respects, compared to the motion of the waves of the sea. It may be observed, that when the tide runs over shoals, and flows upon flat shores, the water is raised to a greater height than in the open and deep oceans that have steep banks; because the force of its motion cannot be broken, upon these level shores, till the water rises to a greater height. If a place communicates with two oceans (or two different ways with the same ocean, one of which is a readier and easier passage) two tides may arrive at that place in different times, which, interfering with each other, may produce a greater variety of phenomena.

An extraordinary instance of this kind is mentioned at Bathsha, a port in the kingdom of Tonquin in the East Indies, of northern latitude 20° 50′. The day in which the moon passes the equator, the water stagnates there without any motion: as the moon removes from the equator, the water begins to rise and fall once a day; and it is high water at the setting of the moon, and low water at her rising. This daily tide increases for about seven or eight days, and then decreases for as many days by the same degrees, till this motion ceases when the moon has returned to the equator. When she has passed the equator, and declines to-

wards the south pole, the water rises and falls again, as before; but it is high water now at the rising, and low water at the setting, of the moon.

TIDE *tables*, are those which set forth the times of high water at sundry places, as they fall on the days of the full and change of moon. These are common in many almanacs, particularly in White's Ephemeris, Nautical Almanac, &c.

TIDE *waiters*, or TIDESMEN, are inferior officers belonging to the custom-house, whose employment it is to watch or attend upon ships, until the customs be paid: they get this name from their going on board ships, on their arrival in the mouth of the Thames or other port, and so come up with the tide.

TIERCE, or TEIRCE, a measure of liquid things, as wine, oil, &c. containing the third part of a pipe, or forty-two gallons.

TIERCED, *tierce*, in heraldry, denotes the shield to be divided by any of the partition lines, as party, coupy, tranchy, or tailly, into three equal parts of different colours or metals.

TIGER. See FELIS.

TILE *ore*, in mineralogy, a species of the copper genus, divided into two subspecies; *viz.* the earthy and indurated. The earth is of a hyacinth-red colour, passing through various shades to a reddish brown: it is intermediate between friable and solid, and occurs massive, disseminated, and incrusting copper pyrites. It slightly soils; is almost coherent, and some varieties incline to solid. It is found in veins, and is usually accompanied with native copper and malachite, and sometimes with red copper ore. The indurated tile-ore is in colour between a hyacinth-red and brownish red: it occurs massive and disseminated, internally glimmering. Before the blowpipe it becomes black; but is infusible without addition: it contains from ten to fifty per cent. of copper: it occurs in veins, and is usually accompanied with copper pyrites, fibrous malachite, and iron ochre. It is found in many parts of Germany, in the copper works in Norway; in Siberia and in Chili. The red varieties contain the greatest quantities of copper, and the brown the greatest quantity of iron. It occurs in almost every place where red copper-ore is found: its name is derived from its colour, and the name of the sub-species from its state of cohesion.

TILIA, in botany, *lime-tree*, a genus of the Polyandria Monogynia class and order. Natural order of Columniferæ. Tiliaceæ, Jussieu. Essential character: calyx five-parted; corolla five-petalled; capsule coriaceous, globular, five-celled, five-valved, opening at the base, one-seeded. There are four species, among which is the T. Europæa, European lime-tree, or linden, is a tall upright tree, with smooth spreading branches, thickly clothed with alternate, heart-shaped, smooth, serrate leaves, pointed at the end, oblique at the base, glaucous beneath, and the veins, where they branch off from the nerve, being furnished with a tuft of glandular wool, as in the laurustinus; the flowers, which are delightfully fragrant, especially at night, come forth in July, in umbels or cymes, on long axillary peduncles; calyx green, with a downy edge; petals yellowish, concave; stamens filiform; stigma five-cleft; germ villose, depressed; capsule smooth, with from four to eight unequal angles, commonly one-celled and one-seeded.

TILLÆA, in botany, so named in honour of Michael Angelo Tilli, professor of botany at Pisa, a genus of the Tetrandria Tetragynia class and order. Natural order of Succulentæ. Sempervivæ, Jussieu. Essential character: calyx three or four-parted; petals three or four, equal; capsule three or four, many-seeded. There are eight species.

TILLER *of a ship*, a strong piece of wood fastened in the head of the rudder, and in small ships and boats called the helm. In ships of war, and other large vessels, the tiller is fastened to the rudder in the gun room: and to the other end there are ropes fastened, which pass upwards to the quarter-deck, where the ship is steered by means of a wheel.

TILLANDSIA, in botany, so named in memory of Elias Tillandsius, professor of physic at Aboa, a genus of the Hexandria Monogynia class and order. Natural order of Coronariæ. Bromeliæ, Jussieu. Essential character: calyx trifid permanent; corolla trifid, bell-shaped; capsule one-celled; seeds comose. There are sixteen species.

TILT *boat*, a boat covered with a tilt; that is, a cloth or tarpaulin, sustained by hoops, for the sheltering of passengers.

TIMBER, includes all kinds of felled and seasoned woods. Of all the different kinds, known in Europe, oak is the best for building, and even when it lies exposed to air and water, there is none equal to it. Fir-timber is the next in degree of goodness for building, especially in this country, where they build upon leases. It differs from oak in this, that it requires not much seasoning, and therefore no great stock is

required before-hand. Fir is used for flooring, wainscoting, and the ornamental parts of building within doors. Elm is the next in use, especially in England and France; it is very tough and pliable, and therefore easily worked; it does not readily split; and it bears driving of bolts and nails better than any other wood; for which reason it is chiefly used by wheel-wrights and coach-makers, for shafts, naves, &c. Beech is also used for many purposes; it is very tough and white when young, and of great strength, but liable to warp very much when exposed to the weather, and to be worm-eaten when used within doors; its greatest use is for planks, bedsteads, chairs, and other household goods. Ash is likewise a very useful wood, but very scarce in most parts of Europe: it serves in buildings, or for any other use, when screened from the weather; handspikes, and oars are chiefly made of it. Wild chesnut-timber is by many esteemed to be as good as oak, and seems to have been much used in old buildings; but whether these trees are more scarce at present than formerly, or have been found not to answer so well as was imagined, it is certain this timber is now but little used. Walnut-tree is excellent for the joiner's use, it being of a more curious brown colour than beech, and not so subject to the worms. The poplar, abel, and aspen trees, which are very little different from each other, are much used instead of fir; they look well, and are tougher and harder.

The goodness of timber not only depends on the soil and situation in which it stands, but likewise on the season wherein it is felled. In this, people disagree very much; some are for having it felled as soon as its fruit is ripe, others in the spring, and many in the autumn. But as the sap and moisture of timber is certainly the cause that it perishes much sooner than it otherwise would do, it seems evident that timber should be felled when there is the least sap in it, viz. from the time that the leaves begin to fall, till the trees begin to bud. This work usually commences about the end of April in England, because the bark then rises most freely; for where a quantity of timber is to be felled, the statute requires it to be done then, for the advantage of tanning.

The ancients chiefly regarded the age of the moon in felling their timber; their rule was to fell it in the wain, or four days after the new moon, or sometimes in the last quarter. Pliny advises it to be in the very article of the change, which happening to be in the last day of the winter solstice, the timber, says he, will be incorruptible. Timber should likewise be cut when of a proper age; for when it is either too young, or too old, it will not be so durable as when cut at a proper age. It is said, that oak should not be cut under sixty years old, nor above two hundred. Timber trees, however, should be cut in their prime, when almost fully grown, and before they begin to decay; and this will be sooner or later, according to the dryness or moistness of the soil where the timber grows; as also according to the size of the trees; for there is no fixed rules in felling of timber, experience and judgment must direct here as in most other cases.

After timber has been felled and sawed, it must be seasoned: for which purpose some advise it to be laid up in a very dry airy place, yet out of the wind and sun, or at least free from the extremities of either; and that it may not decay, but dry evenly, they recommend it to be daubed over with cow-dung. It must not stand upright, but lie all along, one piece over another, only kept apart by short blocks interposed to prevent a certain mouldiness, which they are otherwise apt to contract in sweating on one another; from which arises frequently a kind of fungus, especially if there be any sappy parts remaining. Others advise the planks of timber to be laid for a few days in some pool or running stream, in order to extract the sap, and afterwards to dry them in the sun or air. By this means, it is said, they will be prevented from either chopping, casting, or cleaving, but against shrinking there is no remedy. Some again are for burying them in the earth, others in a heat: and some for scorching and seasoning them in fire, especially piles, posts, &c. which are to stand in water or earth. The Venetians first found out the method of seasoning or charring by fire; which is done after this manner; they put the piece to be seasoned into a strong and violent flame, in this they continually turn it round by means of an engine, and take it out when it is every where covered with a black coaly crust: the internal part of the wood is thereby so hardened, that neither earth nor water can damage it for a long time afterwards.

To measure round timber, let the mean circumference be found in feet and decimals of a foot: square it, multiply this

square by the decimal 0.079577, and the product by the length. Example. Let the mean circumference of a tree be 10.3 feet, and the length 24 feet. Then $10.3 \times 10.3 \times 0.079577 \times 24 = 202.615$, the number of cubical feet in the tree. The foundation of this rule is, that when the circumference of a circle is 1, the area is 0.0795774715, and that the areas of circles are as the squares of their circumferences. But the common way used by artificers for measuring round timber, differs much from this rule. They call one fourth part of the circumference the girth, which is by them reckoned the side of a square, whose area is equal to the area of the section of the tree; therefore they square the girth, and then multiply by the length of the tree. According to their method, the tree of the last example would be computed at 159.13 cubical feet only.

In speaking of the strength of timber, or of several kinds of wood, Mr. Emerson says, that from experiments which he has made, a piece of good oak, an inch square and a yard long, supported at both ends, will bear in the middle for a short time about 330*lbs.* avoirdupoise, but will immediately break with a greater weight. Such a piece, he adds, ought not in practice to be trusted for any length of time with more than one-third, or perhaps one-fourth part of the weight; he then gives a table of the different degrees of strength of several sorts of wood. Other writers who have entered at large on the subject, have considered the strength of materials, timber, &c. as subject to four different kinds of strain. 1. As they may be torn asunder, as in the case of ropes, stretchers, king-posts, tye-beams, &c. 2. As they may be crushed, as in the case of pillars, posts, and truss-beams. 3. As they may be broken across, as happens to a joist or lever of any kind. 4. As they may be wrenched or twisted, as in the case of the axle of a wheel, the nail of a press, &c. It would carry us much beyond the limits of this work to enter at large on these several subjects, we shall therefore confine ourselves to some observations on the strains upon timber, which may be practically useful.

With regard to the cohesion of wood we may premise, 1. that the wood immediately surrounding the pith, or heart, of the tree is the weakest, and its inferiority is so much more remarkable as the tree is older. This at least is asserted by Muschenbroek as the result of experiments, but M. Buffon says, that his experience has taught him that the heart of a sound tree is the strongest; but he gives no instances. It is certain, from many observations on very large oaks and firs, that the heart is much weaker than the exterior parts. 2. The wood next the bark, commonly called the white or blea, is also weaker than the rest; and the wood gradually increases in strength as we recede from the centre to the blea. 3. The wood is stronger in the middle of the trunk than at the springing of the branches or at the root; and the wood of the branches is weaker than that of the trunk. 4. The wood of the north side of all trees which grow in our European climates is the weakest, and that of the south-east side is the strongest; and the difference is most remarkable in hedge row trees, and such as grow singly. The heart of a tree is never in its centre, but always nearer to the north side, and the annual coats of wood are thinner on that side. In conformity with this, it is a general opinion of carpenters, that timber is stronger whose annual plates are thicker. The trachea, or air-vessels, are weaker than the simple ligneous fibres. These air-vessels are the same in diameter and number of rows in trees of the same species, and they make the visible separation between the annual plates. Therefore when these are thicker, they contain a greater proportion of the simple ligneous fibres. 5. All woods are more tenacious while green, and lose very considerably by drying after the trees are felled. The only author who has put it in our power to judge of the propriety of his experiments is Muschenbroek. He has described his method of trial minutely, and it seems unexceptionable. The woods were all formed into slips fit for his apparatus, and part of the slip was cut away to a parallelopiped of one-fifth of an inch square, and therefore one-twenty-fifth of a square inch in section. The absolute strengths of a square inch were as follow:

	lbs.
Locust tree	20,100
Jujeb	18,500
Beech, oak	17,300
Orange	15,500
Alder	13,900
Elm	13,200
Mulberry	12,500
Willow	12,500
Ash	12,000
Plum	11,800
Elder	10,000

	lbs.
Pomegranate	9,750
Lemon	9,250
Tamarind	8,750
Fir	8,330
Walnut	8,130
Pitch pine	7,650
Quince	6,750
Cypress	6,000
Poplar	5,500
Cedar	4,880

M. Muschenbroek has given a very minute detail of the experiments on the ash and the walnut, stating the weights which were required to tear asunder slips taken from the four sides of the tree, and on each side in a regular progression from the centre to the circumference. The numbers of this table corresponding to these two timbers may therefore be considered as the average of more than fifty trials made of each; and he says that all the others were made with the same care. We cannot therefore see any reason for not confiding in the results; yet they are considerably higher than those given by some other writers. M. Pitot says, on the authority of his own experiments, and of those of M. Parent, that sixty pounds will just tear asunder a square line of sound oak, and that it will bear fifty with safety. This gives 8,640 for the utmost strength of a square inch, which is much inferior to Muschenbroek's valuation. We may add to these,

Ivory	16,270
Bone	5,250
Horn	8,750
Whalebone	7,500
Tooth of sea-calf	4,075

The reader will surely observe, that these numbers express something more than the utmost cohesion; for the weights are such as will very quickly, that is, in a minute or two, tear the rods asunder. It may be said in general, that two-thirds of these weights will sensibly impair the strength after a considerable while, and that one-half is the utmost that can remain suspended at them without risk for ever; and it is this last allotment that the engineer should reckon upon in his constructions. There is, however, considerable difference in this respect. Woods of a very straight fibre, such as fir, will be less impaired by any load which is not sufficient to break them immediately. According to Mr. Emerson, the load which may be safely suspended to an inch square is as follows:

Iron	76,400
Brass	35,600
Hempen rope	19,600
Ivory	15,700
Oak, box, yew, plum-tree	7,850
Elm, ash, beech	6,070
Walnut, plum	5,360
Red fir, holly, elder, plane, crab	5,000
Cherry, hazle	4,760
Alder, asp, birch, willow	4,290
Lead	430
Freestone	914

He gives us a practical rule, that a cylinder whose diameter is *d* inches, loaded to one-fourth of its absolute strength, will carry as follows:

	cwt.
Iron	135
Good rope	22
Oak	14
Fir	9

Experiments on the transverse strength of bodies are easily made, and accordingly are very numerous, especially those made on timber, which is the case most common and most interesting. But in this great number of experiments there are very few from which we can draw much practical information. The experiments have in general been made on such small scantlings, that the unavoidable natural inequalities bear too great a proportion to the strength of the whole piece. Accordingly, when we compare the experiments of different authors, we find them differ enormously, and even the experiments by the same author are very anomalous. The completest series that we have yet seen is that detailed by Belidor in his "Science des Ingenieurs." They are contained in the following table. The pieces were sound, even-grained oak. The column *b*, contains the breadth of the pieces in inches; the column *d*, contains their depth; the column *l*, contains their lengths; column *p*, contains the weights (in pounds) which broke them when hung on their middles; and *m* is the column of averages or mediums.

N.	b.	d.		p.	m.	
1	1	1	18	400, 415, 405	406	The ends lying loose.
2	1	1	18	600, 600, 624	608	The ends firmly fixed.
3	2	1	[illegible]	810, 795, 812	805	Loose.
4	1	2	18	1570, 1580, 1590	1580	Loose.
5	1	1	36	185, 195, 180	187	Loose.
6	1	1	36	285, 280, 285	283	Fixed.
7	2	2	36	1550, 1620, 1585	1585	Loose.
8	$1\frac{2}{3}$	$2\frac{1}{4}$	36	1665, 1675, 1640	1660	Loose.

By comparing Experiments 1 and 3, the strength appears proportional to the breadth. Experiments 3 and 4, show the strength proportional to the square of the depth. Experiments 1 and 5, show the strength nearly in the inverse proportion of the lengths, but with a sensible deficiency in the longer pieces. Experiments 5 and 7, show the strengths proportional to the breadths and the square of the depths. Experiments 1 and 7, show the same thing, compounded with the inverse proportion of the length; the deficiency relative to the length is not so remarkable here. Experiments 1 and 2, and Experiments 5 and 6, show the increase of strength, by fastening the ends, to be in the proportion of 2 to 3. The theory gives the proportion of 2 to 4. But a difference in the manner of fixing may produce this deviation from the theory, which only supposed them to be held down at places beyond the props, as when a joist is held in the walls, and also rests on two pillars between the walls. We shall here give an abstract of M. Buffon's experiments. He relates a great number which he had prosecuted during two years on small battens. He found that the odds of a single layer, or part of a layer, more or less, or even a different disposition of them, had such influence that he was obliged to abandon this method, and to have recourse to the largest beams that he was able to break. The following table exhibits one series of experiments on bars of sound oak, clear of knots, and four inches square. This is a specimen of all the rest. Column 1, is the length of the bar in feet clear between the supports. Column 2, is the weight of the bar (the second day after it was felled) in pounds. Two bars were tried of each length. Each of the first three pairs consisted of two cuts of the same tree. The one next the root was always found the heaviest, stiffest, and strongest. Indeed M. Buffon says, that this was invariably true, that the heaviest was always the strongest; and he recommends it as a sure rule for the choice of timber. He finds that this is always the case when the timber has grown vigorously, forming very thick annual layers. But he also observes, that

this is only during the advances of the tree to maturity; for the strength of the different circles approaches gradually to equality during the tree's healthy growth, and then it decays in these parts in a contrary order. Our tool-makers assert the same thing with respect to beech; yet a contrary opinion is very prevalent; and wood with a fine, that is, a small grain, is frequently preferred. Perhaps no person has ever made the trial with such minuteness as M. Buffon, and much deference is thought to be due to his opinion. Column 3, is the number of pounds necessary for breaking the tree in the course of a few minutes. Column 4, is the inches which it bent down before breaking. Column 5, is the time at which it broke.

1	2	3	4	5
7	60 56	5350 5275	3.5 4.5	29 22
8	68 63	4600 4500	3.75 4.7	15 13
9	77 71	4100 3950	4.85 5.5	14 12
10	84 82	3625 3600	5.83 6.5	15 15
12	100 98	3050 2925	7. 8.	

Mr. George Smart, well known for his practical knowledge of mechanics, in almost every department, says, that after making many experiments on timber, and comparing them with those of Belidore, Buffon, &c.: the differences were so great that it would be wasting time to enumerate them. He therefore mentions some useful observations necessary to be known by all those mechanics who use timber; and points out some evident errors in a table of Belidore's, supposed to be the result of the best set of experiments ever produced in transverse strains. He tells us, that a bar of wood, thirty-six inches long, and one inch square, supported at the ends by two props, will break with a weight of 187 pounds on the middle, if it is loose at the ends; but if the ends are firmly fixed, it will require 283 pounds to break it. "This appeared to me," says Mr. Smart, "so great an error, that I was induced to put little or no confidence in many of his experiments; and, in consequence, I made two laths of fir, of the same dimensions, one with a strong shoulder at each end, to prevent its bending, which having firmly fixed in a frame, it carried a weight more than ten times greater than that which was loose."

The fibres of timber requiring so great a force to tear them asunder in a vertical direction, and being easily broken by a transverse strain, when compared to that of a rope carrying nearly an equal weight in all directions, opens a wide field for useful experiments. All timber trees have their annual circles, or growths, which vary greatly according to the soil and exposure to the sun. The north-east side of the trees (being much smaller in the grain than the other parts, which are more exposed to the sun) is strongest for any column that has a weight to support in a vertical direction; because its hard circles, or tubes, are nearer each other, and the area contains a greater quantity of them; nor are they so liable to be compressed by the weight, or to slide past each other, as when they are at a greater distance. On the other hand, this part of the tree is not fit for a transverse strain; because the nearer the hard circles are to each other, the easier the beam will break, there being so little space between them, that one forms a fulcrum to break the other upon; but that part of a tree, the tubes of which are at a greater distance, or of larger grain, is more elastic, and requires a greater force to break it; because the outside fibre on the convex side cannot snap till the next one is pressed upon it, which forms the fulcrum to break it on. It is generally observed in large timbers, such as masts, that the fracture is seldom on the convex, but usually on the concave side; which is owing to the fibres on the concave side being more readily forced past each other, and those on the convex being so difficult to be torn asunder, that they cannot snap, in consequence of the largeness of the segment of the circle they describe when on the strain. The curve described by the inner layers of the wood being so large, and indeed little less than a straight line, cannot form a fulcrum to break the outer ones upon; and as the convex side, or that on which the fibres are extended, ought to be always free from any mortise or incision on the outside, the strength decreases as it approaches the centre. Mr. Smart has, in a paper in the "Repertory," given directions how to cut and join timber so as to have the greatest

strength, and to turn to the greatest advantage, of having the best part of the tree in the place where the hardness and strength are most wanted, *viz.* in the corners which form the abutments; whereas, the same tree squared into a parallel beam, would have been much smaller, and the soft or sappy parts of the wood exposed to the action of the air and moisture. In flush-framing it is observable, that the failure of all timber in old buildings has commenced much sooner than they otherwise would have done, owing to the sappy wood being at the corners of the principal beams, which soon decays, as its spongy quality attracts the moisture; whereas the heart, especially of oak, will be as sound as the first day it was used.

As all beams take their weight horizontally, or on any transverse bearing, have their principal strain on the upper and lower surface, every workman ought to guard against having sap in beams, because if they do not immediately decay, they shrink, so as to let loose all the framing, and soon cripple the building or machine; but on Mr. Smart's plan the sappy part of the wood is excluded from what would cause its decay, and the timber increased in quantity is considerably more than the extra labour and expense.

TIMBER *trees*, in law, are properly oak, ash, and elm. In some particular countries, by local custom, other trees, being commonly there made use of for building, are considered as timber. Of these, being part of the freehold, larceny cannot be committed; but, if they be severed at one time, and carried away at another, then the stealing of them is larceny. And by several late statutes, the stealing of them in the first instance is made felony, or incurs a pecuniary forfeiture. For the better preservation of roots, shrubs, and plants, it is enacted, by 6 George III. c. 48, that every person convicted of damaging, destroying, or carrying away any timber-tree, or trees, or trees likely to become timber, without consent of the owner, &c. shall forfeit for the first offence not exceeding 20*l.* with the charges attending; and on non-payment shall be committed for not more than twelve, nor less than six months; for the second offence, a sum not exceeding 30*l.* and on non-payment shall be committed for not more than eighteen, and not less than twelve months; and for the third offence, is to be transported for seven years. All oak, beech, chesnut, walnut, ash, elm, cedar, fir, asp, lime, sycamore, and birch trees, shall be deemed and taken to be timber trees, within the true meaning and provision of this act. Persons convicted of plucking up, spoiling, or taking away any root, shrub, or plant, out of private cultivated ground, shall forfeit for the first offence, any sum not exceeding 40*s.* with the charges; for the second offence, a sum not exceeding 5*l*, with the charges; and for the third offence are to be transported for seven years. A power is given to justices of the peace to put this act in execution.

TIME, a succession of phenomena in the universe; or a mode of duration, marked by certain periods or measures, chiefly by the motion and revolution of the sun. The idea of time, in the general, Mr. Locke observes, we acquire by considering any part of infinite duration as set out by periodical measures: the idea of any particular time, or length of duration, as a day, an hour, &c. we acquire first, by observing certain appearances at regular, and, seemingly, at equidistant periods. Now, by being able to repeat those lengths or measures of time, as often as we will, we can imagine duration, where nothing really endures or exists; and thus we imagine to-morrow, next year, &c. Some of the latter school-philosophers define time to be the duration of a thing, whose existence is neither without beginning nor end: by which time is distinguished from eternity. Time is distinguished into absolute and relative. Absolute time, is time considered in itself, and without any relation to bodies, or their motions. This flow sequally, *i. e.* never proceeds faster or slower, but glides on in a constant, equable tenor. Relative time, is the sensible measure of any duration, by means of motion. For, since that equable flux of time does not affect our senses, nor is any way immediately cognizable thereby, there is a necessity for calling in the help of some nearly equable motion to a sensible measure, whereby we may determine its quantity by the correspondency of the parts of this with those of that. Hence, as we judge those times to be equal which pass, while a moving body, proceeding with an equable velocity, passes over equal spaces; so we judge those times to be equal, which flow while the sun, moon, and other luminaries, perform their revolutions, which, to our senses, are equal. But since the flux of time cannot be accelerated, nor retarded, whereas all bodies move sometimes faster and sometimes slower, and there is, per-

haps, no perfectly equable motion in all nature, it appears hence to follow, that absolute time should be something truly and really distinct from motion. But, according to Lucretius:

"Time, of itself, is nothing, but from thought
Receives its rise; by labouring fancy wrought
From things consider'd, whilst we think on some
As present, some as past, or yet to come.
No thought can think on time, that's still confest,
But thinks on things in motion, or at rest."

Time *astronomical*, is that taken purely from the motion of the heavenly bodies, without any other regard.

Time *civil*, is the former time accommodated to civil uses, and formed and distinguished into years, months, days, &c.

Time, in music, is an affection of sound, whereby we denominate it long or short, with regard to its continuance in the same degree of time.

TIN, in mineralogy, a genus of metals, of which there are three species: 1. Tin-pyrites; colour intermediate between steel-grey and brass-yellow; but usually more inclined to the first; it occurs massive and disseminated; internally it is glistening, sometimes shining, and seldom passing into splendent; its lustre is metallic; it is brittle, and the specific gravity is somewhere between 4.3 and 4.8. Before the blow-pipe, it gives out a sulphureous odour, and melts easily, without being reduced, into a black scoria. It communicates a yellow or green colour to borax. It consists of

Tin	34
Copper	36
Iron	3
Sulphur	25
Earth	2
	100

It is found at Wheal-rock and St. Agnes in Cornwall, where it occurs in a vein about nine feet wide, accompanied with copper pyrites and brown blende.

2. Tin-stone, which is hard, brittle, and very heavy, the specific gravity being from 5.8 to 6.9 or 7. Before the blow-pipe it decrepitates, becomes paler, and, where it rests on the charcoal, is reduced. When roasted, it is converted into a grey oxide. A specimen, analysed by Klaproth, contained

Tin	77.50
Iron	0.25
Oxygen	21.50
Silica	.75
	100.00

It occurs only in primitive rocks, as granite, gneiss, mica-slate, and clay-slate, and is said to be the oldest of all the metals. It occurs either disseminated in the rock, or in beds, or veins. It is usually accompanied with quartz, mica, &c. and is also found in great quantities in alluvial land. The greater part of the English, much of the Spanish, and the greater proportion of that from India, occurs in that situation.

Tin is not found in many countries; but where it exists at all, it is in very considerable quantities. In Europe there are only three tin districts: the first is in Saxony and Bohemia; the second in Cornwall; and the third is that of Gallicia, on the borders of Portugal. It is found in many parts of Asia, and in South America. It is worked as an ore of tin, and from it all the tin of commerce is obtained. Its name is derived from the quantity of tin which it affords, and its unmetallic aspect.

3. Cornish tin-ore, or wood tin; which, like the last, is very heavy; before the blow-pipe it is infusible; it consists of about 63 parts of tin, with iron and arsenic. It has hitherto been found only in Cornwall, and there in alluvial land. It is very like brown hematite, from which it is distinguished by its colour, its rolled pieces, greater hardness, and higher specific gravity. We now turn to tin, in a chemical view.

Tin is a metal of a silver-white colour, very ductile, and malleable, gives out, while bending, a crackling noise, is fusible at a heat much less than that of ignition, is soluble in muriatic acid, and, by dilute nitric acid, is rapidly converted into a white oxide. Tin has been known from the earliest ages. It was much employed by the Egyptians in the arts, and by the Greeks as an alloy with other metals. Pliny speaks of it under the name of white lead, as a metal well known in the arts, and even applied in the fabrication of many ornaments of luxury. He ascribes to the Gauls the invention of the art of tinning, or covering other metals with a thin coat of tin. The alchemists were much employed in their researches concerning tin, and gave it the

name of Jupiter, from which the salts, or preparations of tin, were called jovial. Since their time, the nature and properties of tin have been particularly investigated by many chemists, and it has proved the subject of some important discoveries in chemical science. Tin exists in nature in three different states. 1. It is found native; 2. In the state of oxide; and, 3. In that of sulphurated oxide. Native tin is in brilliant plates, or regularly crystallized. The native oxide of tin, which is the most common ore of this metal, exists under a variety of forms. It is generally found crystallized. The sulphuret of tin is of a pale, or dark-grey colour, and, when pure, has some resemblance to an ore of silver. To obtain the metal from its ores, they are first roasted, and then treated with a flux, to reduce the metal. After the ore is roasted, it fuses readily with three times its weight of black flux, and a little decrepitated muriate of soda. In the humid way, native tin may be dissolved in nitric acid, which readily oxidates, and reduces it to the state of white powder, which is an oxide of tin; and if it contain iron and copper, these two metals remain in the solution. Tin is of a white colour, nearly as brilliant as silver. The specific gravity of tin is nearly 7.3. It is one of the softest of the metals. It is extremely flexible, and so malleable, that it can be easily beaten out in plates to $\frac{1}{1000}$ part of an inch, which is the thickness of tinfoil. It has little elasticity or tenacity. A wire of this metal, about one-tenth of an inch in diameter, supports a weight of about thirty pounds, without breaking. Tin is susceptible of very considerable expansion, by means of caloric, and on this account it has been proposed to employ it as a pyrometer. Tin is one of the most fusible of the metals, and melts at the temperature of 442°; but it requires a very high temperature to raise it in vapour. If it be allowed to cool slowly, and when the surface becomes solid by pouring out part of the liquid metal, crystals are formed, composed of a great number of small needles. Tin is a good conductor of electricity. It possesses a peculiar odour, which is communicated to the hands by friction. It has also a perceptible taste. When this metal is exposed to the air, it is soon tarnished, and assumes a greyish white colour; but it undergoes no further change. When it is melted in an open vessel, it is soon covered with a greyish pellicle, which is the commencement of the oxidation of the metal. When this pellicle is removed, another forms, and so on successively, till the whole is oxidated. By continuing the heat, and by agitation, the process goes on more rapidly, and the metal is converted into a whitish powder. This oxide contains about twenty parts of oxygen in 100 of the metal. With the addition of lead, to promote the oxidation, this oxide is the putty of tin. It contains about two parts of oxide of lead, and one part of oxide of tin. But when tin is strongly heated, it is converted into a fine white oxide, which, during the process, gives out a vivid white flame. This oxide is condensed in the cold, and crystallizes in shining, transparent needles.

Tin combines with two proportions of oxygen, thus forming two oxides. The yellow oxide, which has the smaller proportion of oxygen, may be prepared by dissolving tin in nitric acid diluted with water, without the aid of heat. By precipitating the oxide with pure potash, it is obtained in the form of a yellowish powder. Its component parts are

Oxygen	20
Tin	80
	100

By dissolving tin in concentrated nitric acid, with the assistance of heat, the whole is converted with effervescence into a white powder, which falls to the bottom of the vessel. The component parts of this oxide are 28 oxygen, and 72 of tin.

Phosphorus combines very readily with tin, by projecting bits of phosphorus on melted tin in a crucible. A phosphuret of tin is thus obtained, which crystallizes on cooling. This compound is of a silvery white colour, may be cut with a knife, and extended under the hammer, but soon separates into plates. Sulphur combines very readily with tin, by adding the sulphur to the metal while in a state of fusion. This compound forms a greyish or bluish matter, which has a metallic lustre, a lamellated structure, and crystallizes in cubes, or in octahedrons. It is decomposed by acids with effervescence. The component parts are, according to Bergman,

Tin	80
Sulphur	20
	100

If equal parts of oxide of tin and sulphur be fused together in a retort, sulphurous

acid, and some sulphur, are disengaged, and there remains in the vessel a compound of a brilliant, golden colour. It crystallizes in six-sided plates. It is not acted on by the acids. When it is strongly heated, it gives out sulphurous acid and sulphur, and there remains behind a black mass, which is sulphuret of tin. This compound, which is a sulphurated oxide of tin, was formerly distinguished by the name of aurum, musivum, musicum, or mosaicum. The component parts of this sulphurated oxide of tin are

Oxide of tin	60
Sulphur	40
	100

Tin enters into combination with many of the metals, and forms alloys with them, some of which are of great importance. It also combines with acids, and forms salts.

Of the alloys, the most important is that of tin and copper, with some other additions, which forms bronze, bell-metal, speculum, metal, &c. The alloy of tin and lead, in equal parts, forms plumbers' solder. The alloy of tin, lead, and bismuth, in the proportions of 3, 5, and 8, forms a compound that melts in a heat somewhat less than that of boiling water. The amalgam of mercury with tin is used in silvering of mirrors. Pewter is an alloy of tin and lead, which was formerly very much used, more so than any other metallic alloy, being the common material for plates, dishes, and other domestic utensils. Its use now is almost universally superseded by pottery, which is lighter, more readily kept clean, and much cheaper, though certainly less durable, on account of the brittleness of the latter. The name of pewter has been given to any malleable white alloy, into which tin largely enters, and its composition is so various, that hardly any two manufacturers employ precisely the same ingredients, and the same proportions. The finest kind of pewter contains no lead whatever, but consists of tin with a small alloy of antimony, and sometimes a little copper; and in all the superior kinds of pewter, the tin forms by far the greater part of the mixture. Pewter may be used for vessels containing wine, and even vinegar, provided there be from 80 to 82 parts of tin in the alloy, without the smallest danger; hence its use as a measure. The specific gravity of a mixture of tin and lead is less than the mean specific gravity of the two metals separately.

Tin is much used, particularly in the state of very thin leaves: it is then called tin-foil. This is made from the finest tin, first cast into an ingot, then laminated to a certain extent, and afterwards beat out with a hammer. Tin is used for tinning copper, iron, &c. and the salts of tin are employed in dyeing.

Tin *plate, tinning*. Tin combines with iron, and adheres strongly to its surface, forming a thin covering. This is one of the most useful combinations of tin, for it renders the iron fit for a great many valuable purposes, for which, otherwise, on account of its strong tendency to oxidation, or rusting, it would be totally inapplicable. This is well known by the name of tin-plate, or white iron. The process of tinning iron is the following: the plates of iron being reduced to the proper thickness, are cleaned by means of a weak acid. For this purpose the surface is first cleaned with sand, to remove any rust that may have formed. They are then immersed in water, acidulated with a small quantity of sulphuric acid, in which they are kept for twenty-four hours, and occasionally agitated. They are then well rubbed with cloths, that the surface may be perfectly clean. The tin is fused in a pot, the surface of which is covered with an oily or resinous matter, to prevent its oxidation.

The plates of iron are then immersed in the melted tin, and are either moved about in the liquid metal, or are dipped several different times. They are then taken out, and rubbed with saw-dust or bran, to remove the impurities from the surface.

TINCTURE, is commonly understood to be a coloured infusion of any substance in alcohol. It is a preparation much employed in Pharmacy, with many articles of the Materia *medica* (which see), particularly vegetable barks, aromatics of all kinds, and many of the resins and gum resins, which yield to alcohol, by infusion, that part of their substance in which most of the medicinal virtue resides.

Tincture, in heraldry, the hue or colour of any thing in coat armour, under which denomination may also be included the two metals, *or* and *argent*, because they are often represented by yellow and white.

TIPHIA, in natural history, a genus of insects of the order Hymenoptera. Mouth with a membranaceous rounded jaw, the mandible arched and acute; no tongue; four feelers, filiform, unequal, and inserted in the middle of the lip; antennæ filiform;

short, convolute; sting concealed within the abdomen. There are about twenty-seven species, in two divisions: A. jaw vaulted; lip membranaceous, emarginate. B. jaw rounded; lip horny, three-toothed.

TIPULA, in natural history, *crane-fly*, a genus of insects of the order Diptera. Mouth with a very short membranaceous proboscis, the back grooved and receiving a bristle; two feelers, incurved, filiform, and longer than the head; the antennæ are mostly filiform. There are nearly one hundred and fifty species, in two sections, distinguished by their wings. The insects in the division A have their wings expanded; those in B have them incumbent,

Most of the insects of this genus are very like the gnat; they feed on various substances: the larvæ are without feet, soft, and cylindrical, with a truncate toothed head; and feed on the roots of plants: the pupa is cylindrical, two-horned before, and toothed behind. The largest of the European tipulæ is T, rivosa, it is found frequently an inch and half in body, and is distinguished by the colour of its wings which are transparent, with large dusky undulations, intermixed with white towards the rib, or upper edge. This insect proceeds from a greyish larva, found beneath the roots of grass in meadows, gardens, &c. and in the months of July and August it changes into a lengthened chrysalis, out of which, in September, proceeds the complete animal. This is known by the title of long-legs, and is frequently seen in houses during autumnal evenings, when, if it be possible, it will destroy itself by flying into the flame of a lighted candle. This propensity is common to many insects, T. tritici, is a very minute insect. The antennæ are moniliform, longer than the thorax; legs very long. The larva is found in the ears of wheat, to which it is very injurious.

TITANIUM, is a metal of a copper red colour, very difficult of fusion, soluble in muriatic acid, from which it may be precipitated by a tincture of galls. This metal was discovered, in 1793, by Klaproth. He obtained it from a mineral called red schorl. In this mineral he found the oxide of a metal different from any other then known. To this, from Meriachan in Cornwall, where it was found, he gave the name of menachanite, but he had not succeeded in reducing it to the metallic state. Klaproth afterwards analyzed the menachanite, and found that it was precisely the same as the oxide of the metal which he discovered in red schorl. To this metal he gave the name of titanium. This metal has been found only in the state of oxide. Red schorl consists entirely of this oxide. It has been found in different countries, as in Spain, France, and Hungary. It is disseminated in the fine specimens of rock-crystal which are brought from Madagascar, crystallized in long brilliant needles; the form of the primitive crystal being a six-sided prism with two-sided summits; that of the molecule is a triangular prism, with right-angled isosceles bases. It is of a red colour, of different shades. It is brittle, but the fragments are so hard as to scratch glass. The specific gravity is from 4.1 to 4.2. The other mineral, to which Klaproth has given the name of titanite, is composed of oxide of titanium, silica, and lime, nearly in equal proportions. Its specific gravity is 3.5. Titanium was obtained by Vauquelin, by reducing the native red oxide. He mixed together 100 parts of this oxide with 50 of calcined borax, and 50 of charcoal, formed into a paste with oil; and exposed the whole to the heat of a forge raised to 166° Wedgwood. By this process he obtained a dark-coloured, agglutinated mass, having a brilliant appearance on the surface. Titanium obtained in this way, is of a reddish yellow colour, shining and brilliant on the surface, and equally brilliant in some of its internal cavities.

Titanium seems to be one of the most infusible metals known. When the red oxide is exposed to heat in a crucible, it loses its lustre, By the action of the blowpipe it is deprived of its transparence, and becomes of a greyish-white colour. On charcoal it becomes still more opaque, and of a slate-grey. The artificial carbonate of titanium, exposed to heat in a crucible, loses $\frac{35}{100}$ of its weight, becomes yellow, and as it cools resumes its white colour. Titanium enters into combination with phosphorus, and forms with it a phosphuret. This was prepared by M. Chenevix, by exposing a mixture of phosphate of titanium, charcoal, and a little borax, in a crucible, to a very strong heat. The phosphuret which he obtained was in the form of a metallic button, of a pale white colour, brittle, and granular, and infusible by the action of the blow-pipe. This metal enters into combination with the acids, and forms salts with them.

If into a phial, filled with muriate of titanium, there is put a stick of tin, and the bottle enclosed with a stopper, a faint rose colour will soon be visible in that part of

the solution adjacent to the tin, which by degrees will deepen to an amethystine red, and extend through the whole liquor. If zinc be substituted instead of tin, the solution will be first violet, and at length indigo blue. Attempts have been made to alloy titanium with other metals but without success. The white oxide, and also titanite, in substance, are said to afford, when mixed with enamel flux, a straw yellow colour; and we are informed that it has been used in the porcelain manufactory at Sévres, as an ingredient in rich browns; but the difficulty of obtaining a regular and uniform tint, has at length occasioned it to be abandoned.

TITHES, are the tenth part of the increase, yearly, arising and renewing from the profits of lands, the stock upon lands, and the personal industry of the inhabitants. And hence they are usually divided into three kinds; praedial, mixed, and personal. Praedial tithes, are such as arise merely and immediately from the ground, as grain of all sorts, hay, wood, fruits, herbs. For a piece of land, or ground, being called in Latin *prædium*, whether it be arable, meadow, or pasture, the fruit or produce thereof is called prædial, and consequently the tithe payable for such annual produce, is called a prædial tithe.

Mixed tithes, are those which arise not immediately from the ground, but from things immediately nourished from the ground; as by means of goods depastured thereupon, or otherwise nourished with the fruits thereof; as colts, calves, lambs, chickens, milk, cheese, eggs.

Personal tithes, are such as arise from the honest labour and industry of man, employing himself in some personal work, artifice, or negotiation; being the tenth part of the clear gain, after charges deducted.

Tithes, with respect to value, are divided into great and small: great tithes, as corn, hay, wood; small tithes, as the prædial tithes of other kinds, together with those that are mixed and personal.

Tithes of common right belong to that church, within the precincts of whose parish they arise. But one person may prescribe to have tithes within the parish of another; and this is what is called a portion of tithes.

No tithe is due *de jure* of the produce of a mine, or of a quarry; because this is not a fruit of the earth, renewing annually; but is the substance of the earth, and has perhaps been so for a great number of years. But in some places tithes are due by custom, of the produce of mines.

No tithe is due of lime: the chalk of which this is made being part of the soil. Tithe is not due of bricks, which are made from the earth itself. Nor of turf, nor of gravel; because both these are part of the soil.

It has been held, that no tithe is due of salt, because this does not renew annually. But every one of these, and all things of the like kind, may by custom become tithable.

If barren land is converted into tillage, no tithe shall be paid for the first seven years: but if it be not barren in its own nature, as if it be woodland grubbed and made fit for tillage; tithes shall be paid presently; for wood-land is fertile, not barren.

Glebe lands, in the hands of the parson, shall not pay tithe to the vicar, nor being in the hands of the vicar, shall they pay tithe to the parson; because the church shall not pay tithes to the church. But if the parson let his rectory, reserving the glebe lands, he shall pay the tithes thereof to the lessee.

No tithes are due for houses; for tithes are only due of such things as renew from year to year. But houses in London are, by decree, which was confirmed by an act of parliament, made liable to the payment of tithes. There is likewise, in most ancient cities and boroughs, a custom to pay tithes for houses; without which there would be no maintenance in many parishes for the clergy.

As to mills, it is now settled by a decree of the House of Lords, upon an appeal from a decree of the Court of Exchequer, that only personal tithes are due from the occupier of a corn mill. And the occupier of a new erected mill is liable to tithes, although such mill is erected upon land discharged of tithes. Cro. Jac. 429.

Agistment, or the feeding of cattle, is subject to tithe. In the strict sense of the word, it means the depasturing of a beast, the property of a stranger: but this word is constantly used in the books for depasturing the beast of an occupier of land, as well as that of a stranger. An occupier of land is not liable to pay tithe for the pasture of horses, or other beasts, which are used in husbandry in the parish in which they are depastured; because the tithe of corn is by their labour increased. But if horses, or other beasts, are used in husbandry out of the parish in which they depastured, an agistment tithe is due for them. No tithe is due for the pasture of milch

cattle which are milked in the parish in which they are depastured; because tithe is paid of the milk of such cattle. Nor is tithe due for the pasture of a saddle-horse, which an occupier of land keeps for himself or servants to ride upon. Cro. Jac. 430. But an occupier of land is liable to an agistment tithe for all such cattle as he keeps for sale. Cro. Eliz. 446. Milk cattle which are reserved for calving, shall pay no tithe for their pasture whilst they are dry; but if they be afterwards sold, or milked in another parish, an agistment tithe is due for the time they were dry. No tithe is due from an occupier of land for the pasture of young cattle, reared to be used in husbandry, or for the pail. Cro. Eliz. 446. But if such young beasts be sold before they come to such perfection as to be fit for husbandry, or before they give milk, an agistment tithe must be paid for them.

If cattle, which have neither been used in husbandry, nor for the pail, are, after having been kept sometime, killed, to be spent in the family of the occupier of the land on which they are depastured, no tithe is due for their pasture. No tithe is due for the cattle, either of a stranger or an occupier, which are depastured in grounds that have in the same year paid tithe of hay. But it is generally true, that an agistment tithe is due for depasturing any sort of cattle the property of a stranger. Cro. Eliz. 276.

No agistment tithe is due for such beasts, either of a stranger or an occupier, as are depastured on the head-lands of ploughed fields: provided these are not wider than is sufficient to turn the plough and horses upon. Nor is tithe due for such cattle as are depastured upon land that has the same year paid tithe of corn.

If land, which has paid tithe of corn one year, is left unsown the next year, no agistment is due for such land; because by this lying fresh, the tithe of the next crop of corn is increased. But if land, which has paid tithe of corn in one year, is left unsown the next year, no agistment is due for such land; but if suffered to lie fallow longer than by the course of husbandry is usual, an agistment tithe is due for the beasts depastured upon such land.

Sheep, after paying tithe of wool, had been fed upon turnips not severed, by which they were bettered to the value of five shillings each, and were then sold: it also appeared, that before the next shearing-time, as many had been brought in as were sold, and that of these tithe of wool had been paid. It was insisted, that if an agistment were to be paid for the sheep sold, it would be a double tithing; but the court held that this was a new increase, and decreed the defendant to account for an agistment-tithe. But in a later case the court held, that no agistment tithe should be paid.

Corn. It is held, that no tithe is due of the rakings of corn involuntarily scattered: Cro. Eliz. 278. But if more of any sort of corn be fraudulently scattered than there would have been if proper care had been taken, tithe is due of the rakings of such corn: Cro. Eliz. 475. No tithes are due of the stubbles left in corn fields after mowing or reaping of corn.

Tithe of hay is to be paid, though beasts of the plough, or pail, or sheep, are to be foddered with such hay. But no tithe is due of hay upon the head lands of ploughed grounds, provided that such head lands are not wider than is sufficient to turn the plough and horses upon.

It is laid down in an old case, that if a man cut down grass, and, while it is in the swathes, carry it away, and give it to his plough-cattle, not having sufficient sustenance for them otherwise, no tithe is due thereof. And in a modern case, the Court of Exchequer was of opinion, that no tithe is due of vetches, or of clover, cut green, and given to cattle in husbandry.

Tithe of wood is not due in common right, because wood does not renew annually; but it was in ancient times paid in many places by custom. Exemptions from tithes are of two kinds; either to be wholly exempted from paying any tithes, or from paying tithes in kind. The former is called *de non decimando*; the latter *de modo decimandi*.

Prescription *de non decimando* is to be free from the payment of tithes, without any recompense for the same. Concerning which, the general rule is, that no layman can prescribe *de non decimando*, that is, to be discharged absolutely of the payment of tithes, and to pay nothing in lieu thereof: unless he begin his prescription in a religious or ecclesiastical person. But all spiritual persons, as bishops, deans, prebendaries, parsons, and vicars, may prescribe generally *in non decimando*.

A *modus decimandi*, usually called by the name of *modus* only, is where there is by custom a particular manner of tithing, different from the general laws of taking tithes in kind. This is sometimes a pecuniary compensation, as so much an acre for the

tithe of land: sometimes a compensation in work and labour; as that the parson shall have only the twelfth cock of hay, and not the tenth, in consideration of the owner's making it for him: sometimes in lieu of a large quantity, when arrived to great maturity; as a couple of fowls in lieu of tithe-eggs, and the like. Any means in short, whereby the general law of tithing is altered, and a new method of taking them is introduced, is called *modus decimandi*, or special method of tithing.

In order to make a *modus* or prescription good, several qualifications are requisite. It must be supposed to have had a reasonable commencement, as that at the time of the composition, the *modus* was the real value in money, although it is now become much less. It must be something for the parson's benefit; therefore, the finding straw for the body of the church, the finding a rope for a bell, the paying five shillings to the parish-clerk, have been adjudged not to be good. But it is a good *modus* to be discharged, that one hath time out of mind been used to employ the profits, for the repair of the chancel, for the parson hath a benefit by that.

A *modus* must be certain; so a prescription to pay a penny, or thereabouts, for every acre of land, is void for the uncertainty. And it has been held, that if a precise day of payment be not alledged, the *modus* will be ill; but now it is holden, that where an annual *modus* hath been paid, and no certain day for the payment thereof is limited, the same shall be due and payable on the last day of the year.

A *modus* must be ancient; and therefore, if it be any thing near the value of the tithe, it will be supposed to be of late commencement, and for that reason will be set aside.

A *modus* must be durable, for the tithe in kind, being an inheritance certain, the recompense for it should be as durable; therefore a certain sum, to be paid by the inhabitants of such an house hath been set aside, because the house may go down, and none inhabit it. And it must be constant and uninterrupted; for if there have been frequent interruptions, no custom or prescription can be obtained. But after it hath been once duly obtained, a disturbance for ten or twenty years shall not destroy it.

When a common is divided and inclosed, a *modus* shall only extend to such tithes as the common yielded before inclosure, such as the tithes of wool, lambs, or agistment: but not to the tithes of hay and corn, which the common, whilst it was common, did never produce.

The parson cannot come himself and set out his tithes without the consent of the owner; but he may attend and see them set out; yet the owner is not obliged to give him notice when he intends to set it out, unless it be by special custom. After it is set out, the care thereof, as to wasting or spoiling, rests upon the parson, and not upon the owner of the land; but the parson may spread, dry, and prepare his corn, hay, or the like, in any convenient place upon the ground, till it be sufficiently weathered, and fit to be carried into the barn. And he may carry his tithes from the ground either by the common way, or such other way as the owner of the land uses to carry away his nine parts. If the parson suffer his tithes to stay too long upon the land, the other may distrain the same as doing damage; or he may have an action on the case: but he cannot put in his cattle and destroy the corn, or other tithe; for that would be to make himself judge what shall be deemed a convenient time for taking it away.

By 1 Geo. I. c. 6. all customary payments due to clergymen, the payment of tithes, &c. is enforced; and the prosecution in this case may be, for any tithes or church-rates, or any customary or other rights, dues, or payments, belonging to any church or chapel, which of right, by law and custom, ought to be paid for the stipend or maintenance of any minister or curate, officiating in any church or chapel; provided that the same do not exceed twenty pounds.

But the time is not limited within which the same shall become due, and if any quaker shall refuse to pay or compound for the same, any parson, vicar, curate, farmer, or proprietor of such tithes, or any church-warden, chapel-warden, or other person, who ought to have, receive, or collect, any such tithes, rates, dues, or payments, may make complaint to any two justices, other than such as is patron of the church, or chapel, or interested in the tithes.

The number of days is not limited between the time of refusal, and the complaint; nor is it hereby required that such complaint shall be in writing. But it will be more conformable to the usual practice in like cases, if it be in writing. Upon which complaint, the said justices are required to summon in writing, under their hands and seals, by reasonable warning,

such quaker, against whom such complaint shall be made. And after appearance, or on default of appearance, (the warning, or summons, being proved before them upon oath), they may proceed to examine on oath the truth of the complaint, and to ascertain and state what is due and payable.

And by order under their hands and seals, they may direct and appoint the payment thereof, so as the sum ordered as aforesaid do not exceed ten pounds. And also such costs and charges, as upon the merits of the cause, shall appear not exceeding ten pounds. And on refusal to pay, any one of the two next justices, by warrant under his hand and seal, may levy the same by distress and sale, rendering the overplus, the necessary charges of distraining being first deducted and allowed by the said justice; unless it be in the case of appeal, and then no warrant of distress shall be granted, till the appeal shall be determined.

As no time is limited for detaining the distress, nor charges allowed for keeping it, it may be sold immediately. Any person, who shall think himself aggrieved by the judgment of the two justices, may appeal to the next sessions; where, if the judgment shall be affirmed, they shall decree the same by order of sessions, and give costs against the appellant, to be levied by distress and sale, as to them shall seem reasonable. And no proceeding herein shall be removed by certiorari, or otherwise, unless the title of such tithes shall be in question.

The withholding of tithes from the parson or vicar, whether the former be a clergyman or lay-appropriator, is among the pecuniary causes cognizable in the ecclesiastical court. But herein a distinction must be taken; for the ecclesiastical courts have no jurisdiction to try the right of tithes, unless between spiritual persons, between spiritual men and laymen, and are only to compel the payment of them, when the right is not disputed.

TOAD, in zoology, belongs to the same genus with the common frog. See RANA.

TOBACCO, in botany. See NICOTIANA.

After sowing tobacco seeds, the ground is watered every day, and in hot weather covered, to prevent its being scorched by the sun; and when the plants are grown to a convenient pitch, they are transplanted into a soil well prepared for their reception: care is also taken to keep this ground clear of weeds, and to pull off the lowest leaves of the plant, that ten or fifteen of the finest leaves may have all the nourishment. When these leaves are ripe, which is known by their breaking when bent, the stalks are cut, and left to dry two or three hours in the sun; after which they are tied together two and two, and hung on ropes under a a shade to be dried in the air. And when the leaves are sufficiently dried, they are pulled from off the stalks, and made up in little bundles; which being steeped in sea water, or, for want thereof, in common water, are twisted in manner of ropes, and the twists formed into rolls, by winding them with a kind of mill around a stick: in which condition it is imported into Europe, where it is cut by the tobacconists for smoking, formed into snuff, and the like. Besides the tobacco of the West Indies, there are considerable quantities cultivated in the Levant, the coasts of Greece and the Archipelago, the island of Malta and Italy.

TODUS, the *tody*, in natural history, a genus of birds of the order Picæ. Generic character: bill thin, depressed, broad, and at the base covered with bristles; nostrils small and oval; toes three before and one behind, the middle much connected with the outer. There are sixteen species, of which the following is the principal.

T. viridis, or the green tody, is of the size of a wren, and is found in the warm climates of America, and in the West Indies. Its colouring is a beautiful combination of green, white, and red. It is solitary, stupid, feeds upon soft insects, frequents moist situations, sitting long together with its head under its shoulder, and may sometimes be taken by the hand. Birds of this genus are principally found in the warmer territories of America, are somewhat allied to the genus of Flycatchers, but are distinguished by a considerable connection between the toes, whereas those of the flycatcher are completely divided. Several species are much larger than the above.

TOISE is a French measure, containing six feet, or a fathom; a square toise is thirty-six square feet. The toise and the fathom correspond in the division of the feet; but these divisions being unequal, it is necessary to observe that the proportion of the yard, as fixed by the Royal Society at London, to the half toise as fixed by the Royal Academy at Paris, is as 36 : 33.355.

TOLUIFERA, in botany, *balsam of Tolu tree*, a genus of the Decandria Monogynia class and order. Natural order of Terebintaceæ, Jussieu. Essential character: calyx five-toothed, bell-shaped; pe-

tals five, the lowest twice as big, obcordate: style none. There is but one species, viz. T. balsamum, balsam of tolu tree. It is a native of Spanish America, in the province of Tolu, near Carthagena; it is a tree of a considerable size, the bark is thick, rough, and of a brown colour, the branches spread wide on every side; leaves alternate, oblong, four inches long, and two broad in the middle, rounded at the base, acuminate at the end, smooth, of a light green colour, on very short foot stalks; the flowers are produced in small axillary racemes, or bunches, each on a slender pedicel; the corolla has four narrow petals of a yellow colour, a little longer than the calyx, and a fifth, the claw of which is of the same length as the other petals, and the top ovate cordate; stamens within the tube, and terminated by oblong erect sulphur-coloured anthers; fruit roundish, the size of a large pea, divided into four cells, each containing one oblong ovate seed. The balsam of Tolu, which is brought to Europe in little gourd shells, is obtained by making incisions in the bark of the tree; it is collected in spoons, which are made of black wax, and from them it is poured into proper vessels; it is of a reddish yellow colour, transparent, in consistence thick, and tenacious; by age it grows hard and brittle, so that it may be rubbed into a powder between the finger and thumb; its smell is extremely fragrant; its taste is warm and sweetish; thrown into the fire it immediately liquifies, takes flame, and disperses its agreeable odour.

TOMENTUM, in botany, *short wool*, a species of hoary or downy pubescence, which covers the surface of many plants, particularly those in the neighbourhood of the sea, and such as in their native soil are exposed to the ravages of bleak and violent winds. The substance in question consists of a number of small hairs, that are so closely interwoven as scarcely to be distinguished by the naked eye, the white appearance arising from their aggregation and compact texture.

TOMEX, in botany, a genus of the Dodecandria Monogynia class and order. Essential character: involucre four or five-leaved; calyx none; corolla five-petalled; nectary scales five, between the lower stamens; berry one-seeded. There are three species, among which we shall notice the T. sebifera, glutinous tomex, or tallow-tree; it grows to a considerable size, with spreading branches; leaves ovate, oblong, quite intire, smooth, alternate, petioled; peduncles lateral, and subterminating, two or three-flowered; berries small, smooth, and blackish. Native of China and Cochin-China. The wood, which is light, and of a pale colour, is used for rafters, studs, &c. in building; the leaves and twigs abound in a viscid juice, and being bruised and macerated in water, render it glutinous, for this reason the natives work up their plaster with it, to render it more tenacious, and also that it may last the longer; a great quantity of a thick white oil is extracted from the berries, of which common candles are made, resembling spermaceti or wax candles, but having an unpleasant smell.

TOMPION, in naval affairs, a circular piece of wood used to stop the mouth of a cannon. At sea the tompions are carefully encircled with tallow or putty, to prevent the penetration of the water into the bore, whereby the powder contained in the chamber might be rendered unfit for service.

TONNAGE, in military and naval affairs, a custom or impost due for merchandize, brought or carried in tons, from or to other nations, after a certain rate, in every ton. The method of finding the tonnage of any ship is by the following rule: Multiply the length of the keel by the breadth of the beam, and that product by half the breadth of the beam, and divide the last product by 94, and the quotient will be the tonnage. *Ex.* Suppose the ship's keel 72 feet, breadth of the beam 24 feet, then $\frac{72 \times 24 \times 12}{94} = 220.6$. The tonnage of goods is sometimes taken by weight, and sometimes by measurement. The method which yields the most is allowed to a vessel. In weight twenty hundred make one ton, but by measurement forty cubic feet are equal to one ton.

TONSELLA, in botany, a genus of the Triandria Monogynia class and order. Essential character: calyx five-parted; petals five; nectary pitcher-shaped; berry one celled, four-seeded. There are two species, viz. T. scandens, climbing tonsella; and T. africana, African tonsella, both natives of Guinea.

TONSILS, in anatomy, two remarkable glands, situated one on each side of the mouth, near the uvula, and commonly called almonds of the ears, from their resembling almonds in figure. Their use is to secrete a mucous humour for lubricating the passages: this they discharge by several irre-

gular but conspicuous foraminæ into the mouth. See ANATOMY.

TONTINE, a variable kind of life annuity, but generally so contrived as to be progressively increasing in amount. It is formed by nominating a certain number of lives within limited ages, who for each one hundred pounds, or any other gross sum paid down, are to receive at first a specific annuity, but as any of the lives fail, their annuity is to be equally divided among those that remain, by which means those who happen to survive a considerable number of years, obtain a large augmentation of their annual receipt, and the life, which is the longest liver of the whole (if there is no restriction to the contrary) gets for the remainder of its continuance, the total sum paid at first to all the nominees. Tontines of this kind, if properly conducted, are considered by some persons as affording an eligible opportunity of making some provision for children, as the nomination of young healthy lives gives a good chance of survivorship. It has several times been attempted to raise money on this species of annuity for the service of government, but it has never been found practicable to obtain any considerable sum in this way; on a smaller scale it has been adopted successfully both in Great Britain and Ireland, for procuring the sums necessary for building bridges, large inns or hotels, and other expensive edifices.

Of late years many delusive schemes have been set on foot under the name of tontines, but differing very materially from the plan above mentioned, as they do not require a gross sum to be paid down, but quarterly or half yearly payments during their continuance, which is limited to the short period of five, seven, or ten years; the intention being, that the subscribers should receive back all they had contributed, with the additions made to it from improvement at compound interest, and the division of the contributions of such as might happen to die within the term. But the difference between compound and simple interest in the improvement of such payments, for a short time, is so trifling, and the probability of any considerable reduction, during such term, in the number of a set of young lives, who it may be presumed were thought healthy subjects at the time of their nomination, is so small, that the advantages derived from these sources have been sometimes overbalanced by the expenses of management, and, in fact, in several instances of these schemes, which have expired within these few years past the subscribers have actually received considerably less than the payments they had made would have amounted to without any improvement at interest.

TOP, in naval affairs, a sort of platform surrounding the lower mast head, from which it projects on all sides like a scaffold. The intention of the top is to extend the top-mast shrouds so as to form a greater angle with the mast, and thereby give additional support to the latter. The top is likewise convenient to contain the materials necessary for extending the small sails, and for fixing and repairing the rigging and machinery with greater expedition. In ships of war, the tops are furnished with swivels, musketry, and other fire-arms, and are guarded with a fence of hammocks in time of action. In this case the top is used as a kind of redoubt; and is accordingly fortified for attack or defence, being furnished with arms, and guarded by a thick fence of corded hammocks. The top is employed likewise as a place for looking-out, either in the day or night.

TOPAZ, in mineralogy, is a species of the flint genus, of a wine-yellow colour, of all degrees of intensity, and passing to various other colours. It occurs massive, disseminated, sometimes in rolled pieces, but commonly crystallized. There are many varieties. Specific gravity, according to Werner, is about 3.5. The Saxon variety, in a gentle heat, turns white; but a strong heat deprives it of lustre and transparency: the Brazilian, by exposure to a high temperature, burns rose-red; and in a still higher, violet-blue. Before the blow-pipe it is scarcely fusible; but exposed to a stream of oxygen gas, it melts into a porcellanous bead. It is fusible with borax, but alkali has little effect on it. The Brazilian, Siberian, and other topazes, when heated, exhibit at one extremity positive, and at the other negative electricity. The Saxon topaz, by friction only, gives signs of electricity. The constituent parts are, according to Vauquelin,

Silica	31
Alumina	68
Loss	1
	100

It is found in veins that traverse primitive rocks, accompanied by fluor-spar, tin ore, and arsenical pyrites. It is found in Brazil; in Siberia, among the Uralian moun-

tains. The topaz of the ancients is supposed to be our chrysalite. The Saxon topaz is most valued by jewellers, though even this is in no very high estimation.

TOPIC, in rhetoric, denotes a probable argument, drawn from the several circumstances of a fact, &c. Hence the art of finding and managing such arguments is called by the ancients topica.

TOPOGRAPHY. This term is applied to all those writings which have for their subject the description of tracts of country, and the buildings on their surfaces. We often meet with passages in the works of ancient authors which are topographical, or in other words, descriptive of particular places; but rarely or never with volumes dedicated wholly to this purpose. The scriptures have many of the former, particularly the account of Solomon's temple: Homer abounds with such in his Iliad and Odyssey, and Virgil in his Æneid; to which might be added subsequent writers, though not of equal celebrity. The two Pliny's have favoured us with sketches of this nature, one of which, by the younger, we shall introduce as a specimen. Speaking of his Tuscan villa, he says, "The face of the country is extremely beautiful. Imagine to yourself an amphitheatre of immense circumference, such as could be formed only by the hand of nature: a wide-extended plain is surrounded by mountains, whose summits are covered with tall, ancient woods, stocked with game for all kind of hunting; the descent is planted with underwoods, among which are frequently little risings, of a rich and deep soil, where a stone, if sought for, is scarce to be found: in fertility they yield not to the finest vales, and produce as good crops of corn, although not so early in the year. Below these, on the side of the mountain, is a continued range of vineyards, that extend themselves without interruption far and near, at the foot of which is a sort of border of shrubs. From thence you have meadows and open fields: the arable grounds require large oxen and the strongest ploughs; the earth is so tough, and rises in such large clods when it is first broken up, that it cannot be reduced till it has been ploughed nine times: the meadows glitter with flowers, and produce the trefoil and other kinds of grass, always soft and tender, and appearing always new; for they are excellently well watered with never-failing springs; yet where these springs are in greatest confluence, they make no marshes, the declivity of the land discharging into the Tiber all the water that it does not drink in."

Had it been the custom at those very distant periods of time to write thus, frequently, and had the art of printing been then invented, how much valuable information would have reached us that is now irretrievably lost; and with what pleasure should we have read descriptions of many important places, the scites of which are now only known by conjecture from some casual circumstance! Numbers of beautiful cities, far surpassing any existing at present in the magnificence of their public structures, have been deserted, through different causes, by their inhabitants, and are yet splendid in their ruins: those offered every incitement for description, but have perished without obtaining this act of justice. Egypt, in particular, furnished the writer with the means of immortalizing his name as a topographer; and it is a subject of severe regret, that we have not been gratified by an account of that country, when all the wonderful fragments scattered over its surface were connected by the chain of society, and perfect in themselves; then, we have every reason to suppose, rich woods fringed the borders of their cities, and extensive gardens afforded equal pleasure and advantage to the inhabitants: like a sublime picture, we should have been enabled to contrast its ancient softest tints with its present dreary wastes and gloomy ruins.

The French have ever been an enterprizing people, and very early turned their attention to travelling, and topographical description; an interesting account of which may be found in Mr. Johnes's recent translation of "Bertrand de la Broquiere's Travels in Palestine," about the year 1432. The English nation did not entirely neglect this species of literature, in the earliest periods of their annals; as several monks might be mentioned, who gave their brethren, in different parts of the country, manuscript accounts of the foundations of their monasteries, and some slight description of them and their scites. We shall introduce the title of one of those, quoted by Mr. Malcolm, in his "History of St. Bartholomew's Priory, London," in order to convey to the reader an idea of their abilities in our language, about the time of Henry III. or perhaps rather earlier: "For as mooche that the meritory and notable operacyons of famose goode and devoute faders yn God sholde be remembred,

for instruction of aftercūmers to theyr consolacion and encres of devotion; thys abbrevyat tretesse shal compendiously expresse and declare the wondreful, and, of celestial concel, gracious foundacion of our hoely placeys, called the priory of Seynt Bartholomew yn Smythfyld, and of the hospital of olde tyme longyng to the same; with other notabilities expediently to be knowyn; and most specially the gloriouse and excellent myracles wroghte withyn them by the intercessions, suffrages, and merytys of the forsayd benynge, feythful, and blessid of God, apostyl Sanct Bartholomy, ynto the laude of Almighty God, and agnicion of his infinite power. Ffyrst shal be shewyd who was ffunder of owere hoely places, and howgh, by grace, he was ffyrst pryor of owr priory; and by howgh longe tyme that he contynued yn the same. Thys churche, yn the honoure of most blessed Bartholomew apostle, ffunded Rayer, of good remembraunce. And theryn to serve God (after the rewle of the most holy fader Austyn) aggregat togidir religiouse men. And to them was prelate xxii yere; usynge the office and dignite of a priore." This ancient topographer mentions that Rahere, the prior and founder of the priory, died in the reign of king Stephen, and was succeeded by Thomas, in the year 1144. The following passage will prove that the manuscript was written immediately after the above period: "And yn what ordur he sette the fundament of this temple yn fewe wordes lette us shewe, as they testified to us *that sey him*, *herd him*, and were presente yn his workys and dedis; *of the whiche* sume have take ther slepe yn Cryiste, and *sume of them be zitte alyre*, and wytnesseth of that that we shall after say."

It may be perceived from this specimen of early topography, that we had by no means arrived to the degree of excellence which Pliny and his contemporaries attained in similar productions; neither did we accomplish this very desirable point till within the last century. Those who have perused our best works, historical and descriptive, before the reign of George II. will find great accuracy and deep research; but unfortunately we learn nothing of the nature and beauties of the surface of the earth, or of the proportions and sculptures of our buildings, from the valuable works of Leland, Stowe, Speed, Camden, Dugdale, &c.; indeed, had not Hollar been employed by the latter, his splendid accounts of monasteries, and St. Paul's, would have given us no idea whatever of the richness of their forms and decorations.

It is, however, to the authors, whose names we have recapitulated, that we are indebted for admirable models in topography; and it would be injustice to the moderns to deny them the merit of having greatly improved upon them, by their descending to the minutiæ which seems to have escaped the attention of their great predecessors. The public has for a very considerable length of time been extremely partial to topographical works, which is evinced by the shoals of publications issued from the London and provincial presses on this subject. The metropolis has had every thing said of it which the art of man could rake together; almost every county has its historian, and some have had several; the cities have each been described, and every town, worth or not worth a description, has its guide; and, exclusive of those, numbers of tours are continually making their appearance. It appears almost invidious to mention any particular exertions, without enumerating every well-founded pretension to public approbation; and yet we cannot conclude this article accurately without observing, that Gough's edition of Camden's "Britannia," and his "Sepulchral Monuments" of this kingdom, are worthy of ranking with the works of our best ancient topographers; and that amongst the many excellent county histories we possess, none has a greater claim for extent and accuracy than the "History of Leicestershire," by Mr. John Nichols. The environs of London have received every possible attention from the indefatigable brothers, Daniel and Samuel Lysons, who are now pursuing a most laborious undertaking on nearly the same plan, to be extended to all England; and of London, the great centre, every thing has been said by Stowe, Strype, and Malcolm; besides the slighter performance of Pennant, to whom we are more indebted for his other topographical works; and, to conclude, we now possess a Topographical Dictionary, the patient and useful production of Mr. Carlisle.

The encouragement all these and similar publications have hitherto uniformly met with, has been eminently advantageous to draftsmen and engravers, whose works, for the embellishment of topographical writings, are not surpassed by any which have made their appearance on the Continent; an assertion that may be proved decidedly by referring to the recent publications—

"The Beauties of England and Wales," and "The Architectural Antiquities of Great Britain;" two of the best, without exception, that have ever issued from the British press; the joint performance, in the first instance, of Messrs. Britton and Brayley, and in the second, of the former only.

TORDYLIUM, in botany, *heart-wort*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ, or Umbelliferæ. Essential character: corolla radiate; all hermaphrodite; fruit suborbicular, notched at the edge; involucres long, undivided. There are seven species.

TORENIA, in botany, so named from Olof Toreen, a Swedish clergyman, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: calyx two-lipped, upper lip three cusped; filaments, the lower with a sterile branchlet; capsule two-celled. There are three species.

TORMENTILLA, in botany, a genus of the Icosandria Polygynia class and order. Natural order of Senticosæ. Rosaceæ, Jussieu. Essential character: calyx eight-cleft, inferior; petals four; seeds roundish, naked, wrinkled, fastened to a small, juiceless receptacle. There are two species; *viz.* T. erecta, common tormentil; and T. reptans, trailing tormentil. Natives of Europe.

TORNADO, a sudden and vehement gust of wind from all points of the compass, frequent on the coast of Guinea.

A tornado seems to partake much of the nature of a whirlwind, or perhaps of a water-spout, but is more violent in its effects. It commences very suddenly, several clouds being previously drawn together, when a spout of wind, proceeding from them, strikes the ground, in a round spot of a few rods or perches diameter, and proceeds thus half a mile or a mile. The proneness of its descent makes it rebound from the earth, throwing such things as are moveable before it, but some sideways or in a lateral direction from it. A vapour, mist, or rain, descends with it, by which the path of it is marked with wet. The following is a description of one which happened a few years since at Leicester, about fifty miles from Boston, in New England: it happened in July, on a hot day, about four o'clock in the afternoon. A few clouds having gathered westward, and coming overhead, a sudden motion of their running together in a point being observed, immediately a spout of wind struck the ground at the west end of a house, and instantly carried it away, with a negro man in it, who was afterwards found dead in the path of it. Two men and a woman, by the breach of the floor, fell into the cellar; and one man was driven forcibly up into the chimney-corner. These were preserved, though much bruised; they were wet with a vapour or mist, as were the remains of the floor, and the whole path of the spout. This wind raised boards, timbers, &c. A joist was found on one end, driven nearly three feet into the ground. The spout probably took it in its elevated state, and drove it forcibly down. The tornado moved with the celerity of a middling wind, and constantly declined in strength till it entirely ceased.

TORPEDO. See RAIA.

TORRENT, in geography, denotes a temporary stream of water, falling suddenly from mountains, whereon there have been great rains, or an extraordinary thaw of snow.

TORRICELLI (EVANGELISTE), in biography, an illustrious mathematician and philosopher of Italy, was born in 1608, and trained up in the knowledge of classical literature. The bent of his mind, however, led him to the pursuits of natural philosophy, which he studied under father Benedict Castelli, who had been the scholar of the great Galileo, and was professor of mathematics at Rome. Torricelli made such progress under this master, that having read Galileo's "Dialogues," he composed a "Treatise concerning Motion" upon his principles. Castelli, surprised at the performance, carried it and read it to Galileo, who heard it with great pleasure, and conceived a high esteem and friendship for the author. Upon this, Castelli proposed to Galileo, that Torricelli should come and live with him; recommending him as the most proper person he could have, since he was the most capable of comprehending those sublime speculations, which his own great age, infirmities, and want of sight, prevented him from giving to the world. Galileo accepted the proposal, and Torricelli the employment, as things of all others the most advantageous to both. Galileo was at Florence, at which place Torricelli arrived in 1641, and began to take down what Galileo dictated, to regulate his papers, and to act in every respect according to his directions. But he did not long enjoy the advantages of this situation, as Galileo died at the end of only three months.

Torricelli was then about returning to Rome; but the Grand Duke engaged him to continue at Florence, making him his own mathematician for the present, and promising him the professor's chair as soon as it should be vacant. Here he applied himself intensely to the study of mathematics, physics, and astronomy, making many improvements, and some discoveries. Among others, he greatly improved the art of making microscopes and telescopes; and it is generally acknowledged that he first found out the method of ascertaining the weight of the atmosphere by a proportionate column of quicksilver, the barometer being called from him the Torricellian tube, and Torricellian experiment. Great things were now expected from him, and great things would probably have been further performed by him, if he had lived; but he died, after a few days illness, in 1647, when he was but just entered the 40th year of his age. His principal work was entitled, "Opera Geometrica," in 4to.

TORRICELLIAN *experiment*, a famous experiment made by Torricelli, a disciple of the great Galileo, which has been already explained under the article BAROMETER. See also PNEUMATICS.

TORRID *zone*, among geographers, denotes that tract of the earth lying upon the equator, and on each side as far as the two tropics, or 23° 30′ of north and south latitude. The torrid zone was believed by the ancients to be uninhabitable; but is now well known to be not only inhabited by the natives of those hot climates, but even tolerable to the people of the colder climates, towards the north and south; the excessive heat of the day being there tempered by the coldness of the night. See the article HEAT.

TOUCH, or FEELING, *sense of*. When the mind has connected the complex ideas derived from the touch with the visible appearance of objects, then the sight is indefinitely the most useful medium of knowledge: but in the earliest stages of the intellectual progress, the touch is the most useful; in fact, as man is formed, it then is absolutely necessary to render the sight productive of most of its present utility. The sense of feeling differs from the other senses in belonging to every part of the body, external or internal, to which nerves are distributed. The term touch is most correctly applied to the sensibility which is diffused over the surface of the body. Touch exists with the most exquisite degree of sensibility at the extremities of the fingers and thumbs, and in the lips. The sense of touch is thus very commodiously disposed for the purpose of encompassing smaller bodies, and for adapting itself to the inequalities of larger ones.

The sensations acquired by the sense of feeling are those of heat, hardness, solidity, roughness, dryness, motion, distance, figures, &c. and all those corporeal feelings which arise from a healthy or diseased state of the nerves, and the part of the body to which they belong.

The pains of this sense are more numerous and vivid than those derived from any other sense; and therefore the relicts of them coalescing with one another, constitute the greatest share of our mental pains, that is, pains not immediately derived from sensation. On the other hand, its pleasures being faint and rare, in comparison with others, and particularly those of the taste, have but a small share in the formation of the mental pleasures.

The touch is the original medium of our knowledge respecting the real qualities of substances, and is indeed the sole medium by which we gain a knowledge of external objects. It is by the touch, and by the touch alone, originally, that we distinguish our own bodies from other objects that surround us, and form the impression which every one has, that the objects which affect the sight, the hearing, &c. are external. When we touch a sensible part of our bodies, we have sensations conveyed to the mind through two different nervous branches; when we touch any other body, we have only one sensation.

The impression that they are external objects, that is, objects out of ourselves, which give us the sensations of sound, taste, sight, and smell, is so continually forced upon us by the sensations of touch, that there probably never was found a person who doubted the existence of the external world as the cause of his sensations, except those who have been led to it by reasoning on false principles. Some very acute speculators have indeed given up the belief in an external world as the cause of their sensations; but their opinion never did, nor never can, gain much ground; for it is inconsistent with the perceptions, which, by the constitution of our frame, are necessarily formed from continually recurring sensations. The philosophic Berkeley, and a late writer, Drummond, are the principal supporters of this curious system. But if

we had not the sense of touch, the other senses would have produced no such impression; sensations would have appeared to arise in the mind without any connection with external causes of them.

Some philosophers have supposed, that it is the exquisite delicacy of feeling which exists in the hand: and the admirable mechanism by which it is applied, which is the cause of the superiority of knowledge which man possesses over the lower classes of animals. It cannot be just to attribute to this cause alone this superiority, but indisputably, as man is constituted, it is essential to the degree of superiority now possessed; and we observe, that that tribe of animals possesses the greatest degree of what may be called human wisdom, which has this sense most perfect; the bended muscle at the end of the elephant's trunk answering some of the purposes of the human fingers.

Touch *needle*, among assayers, refiners, &c. little bars of gold, silver, and copper, combined together in all the different proportions and degrees of mixture; the use of which is to discover the degree of purity of any piece of gold or silver, by comparing the mark it leaves on the touch-stone with those of the bars.

The metals usually tried by the touchstone are gold, silver, and copper, either pure, or mixed with one another in different degrees and proportions, by fusion. In order to find out the purity or quantity of baser metal in these various admixtures, when they are to be examined, they are compared with these needles, which are mixed in a known proportion, and prepared for this use. The metals of these needles, both pure and mixed, are all made into laminæ or plates, one twelfth of an inch broad, and of a fourth part of their breadth in thickness, and an inch and a half long; these being thus prepared, you are to engrave on each a mark indicating its purity, or the nature and quantity of the admixture in it.

TOURMALINE. See Schorl.

TOURN, the sheriff's tourn, is the king's court of record, holden before the sheriff, for redressing of common grievances within the county. This is not now held.

TOURNEFORTIA, in botany, so named in memory of Joseph Pitton Tournefort, a genus of the Pentandria Monogynia class and order. Natural order of Asperifoliæ. Borragineæ, Jussieu. Essential character: berry two-celled, two-seeded, superior, perforated at top by two pores. There are eleven species; these shrubs are mostly natives of South America; several of them were first discovered by Father Plumier, who gave them the name of Pittonia, which Linnæus changed to Tournefortia.

TOURNEQUET, in surgery, an instrument made of rollers, compresses, screws, &c. for compressing any wounded part, so as to stop hæmorrhages.

TOURRETTIA, in botany, so named from Mons. de la Tourrette, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Bignoniæ, Jussieu. Essential character: calyx two-lipped; corolla, lower lip none, but two toothlets instead of it; capsule echinate, four-celled, two-valved. There is only one species, *viz.* T. lappacea, a native of Peru.

TOW *to*, in naval affairs, is to draw a ship, or boat, forward in the water, by means of a rope attached to another vessel or boat, which advances by the effort of rowing or sailing. Towing is either practised when a ship is disabled, and rendered incapable of carrying sail at sea; or when her sails are not fixed upon the masts, as in a harbour, or when they are deprived of their force of action by a cessation of the wind.

TOWER, a tall building, consisting of several stories, usually of a round form, though sometimes square or polygonal. Towers are built for fortresses, prisons, &c. as the Tower of London, the Tower of the Bastile, &c. The Tower of London is not only a citadel to defend and command the city, river, &c. but also a royal palace, where our kings, with their courts, have sometimes lodged; a royal arsenal, wherein are arms and ammunition for sixty thousand soldiers; a treasury for the jewels and ornaments of the crown; a mint for coining of money; the great archive, wherein are preserved all the ancient records of the courts of Westminster, &c. and the chief prison for state criminals.

TOZZIA, in botany, so named in honour of Bruno Tozzia, abbot of Vallumfrosa, F. R. S. a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Lysimachiæ, Jussieu. Essential character: calyx five-toothed; capsule one-celled, globular, one-seeded. There is only one species, *viz.* T. alpina, a native of the mountains of Switzerland, Austria, South of France, Italy, and the Pyrenees.

TRACHELIUM, in botany, *throat-wort*, a genus of the Pentandria Monogynia class

and order. Natural order of Campanaceæ. Campanulaceæ, Jussieu. Essential character: corolla funnel-form; stigma globular; capsule three-celled, inferior. There are three species, all found at the Cape of Good Hope.

TRACHICHTHYS, in natural history, a genus of fishes of the order Thoracici. Generic character: head rounded in front, eye large, mouth wide, toothless, descending; gill-membrane eight-rayed; the four lowest rays rough on the edges; scales rough; abdomen mailed with large carinated scales. The only species under this genus is T. australis, or the southern trachichthys, about five inches long, and two deep, and a native of New Holland. Its body is so strongly coated with scales, that they cannot be detached without part of the skin. Its eyes are extremely large, its tail is strongly forked, and its abdomen is carinated, and cataphracted, by a row of eight strong scales, each of which projects into a short spine pointing backward, and forming a sharp keel beneath. See Plate VI. Pisces. fig. 7.

TRACHINUS, in natural history, a genus of fishes of the order Jugulares. Generic character: head compressed, spinous at the top; gill membrane six-rayed, the covers aculeated; lower lamina serrated. There are two species. T. draco, or the dragon-weaver, is usually about eleven inches long, and inhabits the North Seas and the Mediterranean, often imbedding itself in the sand on the coasts. It feeds on worms, insects, and small fishes, and is in great estimation in various countries of Europe for the table. It is remarkable principally for inflicting very painful wounds with its first dorsal fin, which is armed with five strong and sharp spines. The wounds thus given are attended with great heat and violent redness, and are not a little dreaded by the fishermen of France and Holland.

TRADE, the practice of exchanging goods, wares, money, bills, and other articles of value, with the view of advantage or profit. It is generally distinguished into foreign trade, or the export and import of commodities to and from other countries, and the internal or home trade, or that which is carried on within the country; which two branches, however, are rather distinct in appearance than reality: one supports the other, and by their mutual connection and dependence the foreign and the domestic trade of Great Britain have risen together to their present unparalleled height. See COMMERCE and MANUFACTURES.

By the law of England, trade is considered so much for the general benefit, that, by several statutes, particularly Magna Charta, 9 Henry III. c. 30, and 5 Richard II. c. 1, even all merchants, aliens, and not enemies, may safely come and go, and abide here, and deal, in gross or by retail, in any commodities; but, by statute 16 Richard II. c. 1, this was restrained, to prevent merchants, aliens, from selling any thing by retail except victuals. And by several statutes, remedies are given for alien merchants against those by whom they may be disturbed in their dealings. But an alien cannot take a lease of a house, though he is a merchant; but may be a tenant at will. And no alien shall be a merchant or factor, unless naturalized, or made denizen, in the English plantations in Asia, Africa, or America. Some restraints are also put upon the importation of certain articles by statute 11 Edward III. c. 3; 3 Edward IV. c. 4; 19 Henry VII. c. 21; 25 Henry VIII. c. 9; and 5 Elizabeth c. 7.

The seas shall be open to all merchants; and all subjects may trade to Spain, France, and Portugal, paying the customs. In England all persons are free to use any trade, unless restrained by act of parliament, or the bye-laws of some corporations, or by the King's charter; for he may erect a corporation for the management of certain trades, and may even make a monopoly of some things, such as the sole printing of books of the common law, statute books, English bibles, prayer books, civil law books, and even school books, as it is said. But this prerogative is somewhat odious, and has not recently been enforced, excepting in respect to bibles, the statutes, and prayer books.

But the King cannot by his charter make a total restraint of trade. Even with respect to excluding the exercise of a trade in a town, or city, without being free of it, there is great doubt whether a charter with such an exclusive privilege is valid, except as to London, where the bye-laws are confirmed by act of Parliament, although many such privileges are assumed elsewhere, and rest for their validity entirely upon ancient custom. The exclusive trade of the East India company is founded upon a charter, confirmed by act of parliament, 9 and 10 William III. c. 44, and subsequent statutes and by 37 George III. c. 97, trade is allow-

ed under the previous treaty with America between that country and our settlements in the East Indies, either direct or by way of Europe.

If a man contract, even for a good consideration, not to exercise a certain trade generally, such an agreement is void, as being in restraint of trade; but an agreement not to exercise a certain trade within a certain town, to the prejudice of another, is valid.

By the statute 5 Elizabeth, c. 4, none shall use any manual occupation then used in the realm, unless he has been brought up in it as an apprentice for seven years, under a penalty of 40*s.* per month. This statute has by some been considered as impolitic, and in general may be considered as a very slight restraint upon one who is successful in the trade. It has received a very liberal construction, so that, if a man has worked as a journeyman or master for seven years, he is considered to have served as an apprentice; and a person who is qualified, and directs the business, may have another in partnership who is not qualified. A trade is not transmissible, so as to go to executors; for if they carry it on, they must be personally liable.

The principal restraint upon trade which now exists is by the statutes respecting literary property (see that article), and the exclusive rights of inventors, under a patent for a limited time. These letters patent must be for the invention of new manufactures or machines, and are to be granted only for fourteen years from the date of the patent. Statute 21 James I. c. 3. In order to render such a patent valid, it must be under the great seal, and must be inrolled, and a specification of the particular process, or invention, must be inrolled in Chancery within six months. It is upon the novelty of the manufacture, as it respects England, and the fidelity of the specification, that the validity of the patent depends; for if a process is not fully and fairly described, or is described with any degree of fraud or concealment, the patentee cannot enforce the benefit of his invention, and the patent may be repealed upon application to the Chancellor by *scire facias*. Although an invention is not new abroad, yet if it has not been used here, a patent may be taken for it. See PATENT.

The aggregate gain which individuals engaged in foreign trade derive from it, can by no means be considered as shewing the accession of wealth which the nation receives from this source. Many circumstances may concur to diminish, or even wholly to destroy, the profit of foreign trade in this point of view, by which the gains of the merchant, and others, by whom it is carried on, are not in the least affected; thus, the payments made to other countries for the dividends on the share foreigners hold of our public debts; remittances of subsidies, or for the maintenance of troops; and the money spent abroad by British subjects occasionally resident there, all operate to the reduction of the actual wealth which this country would otherwise derive from its intercourse with other nations, which may therefore be very different from the general profit derived from trade, as a sum equal to the greater part, or even the whole, of the commercial gain may annually, or occasionally, be sent out of the country in the various ways just mentioned.

The balance of trade in favour of this country has usually been estimated from the excess of the exports beyond the imports, and a comparatively small amount of the latter has been always considered highly desirable. This is a concise mode of determining a very important point; but it is certainly very erroneous; for, in this view, the whole of the imports are considered as if they were paid for; whereas, in fact, a very large part of the imports never require to be paid for at all, and instead of tending to draw money out of the country, ought to be considered as an annual accession of wealth. This particularly refers to the imports from India, as far as they are purchased by the territorial revenues of that country, or by the private capitals of individuals acquired there; to such proportion of the imports from the West Indies as are remittances from the income of individuals residing here; and to the profits arising from fisheries carried on in different parts of the world by subjects of this country ordinarily residing here. Besides the evident impossibility of making this distinction in the account of imports, the custom-house statements, both of the imports and exports, are totally inadequate to show even their comparative amounts, as almost every article of merchandize is there rated at a value entirely different from its present actual value; but even if these accounts of the exports and imports were far better adapted to show on which side the balance really lies than they are, it will be easily proved that all the statements founded on them, in which the annual gain of the country from

trade is exhibited by the excess of exports, must be inaccurate. Suppose the merchants of this country to purchase, for exportation, on their own account, British manufactures to the amount of 20,000,000*l.*; the net proceeds thereof in the countries to which they are exported, after paying all charges, cannot be considered as less than 22,000,000*l.*, and this sum being invested in foreign produce, and imported into this country, will amount, after repaying the duties and all expences, to at least 24,200,000*l.* returning the merchants the capital they had originally advanced, with a profit of 21 per cent. Here is an evident gain to the country of 4,200,000*l*, because the goods brought into it, exceed in value those which were sent out by this sum. Will those who discover the commercial profits of the country in a small amount of imports, pretend that the advantage of the merchants, or of the state, would have been greater, if the imports received in return for the twenty millions sent out had been only of sixteen millions value?

If the merchandize imported in return for any quantity exported is of greater actual value in this country, that is, if it yields a greater price after allowing for all charges, and the interest of the capital employed, the surplus must be an addition to the wealth of the nation; and if the whole of our foreign trade was of this description, the excess of the imports would show the total profit, or the acquisition of wealth, by the exchange of commodities with other nations. It may, however, frequently happen, that a country carrying on a profitable commerce may not have occasion for an amount of equal or greater value than its exports in the produce or manufactures of other countries, in which case the imports from other countries will diminish, and the difference must be made up by coin or bullion, which, in a commercial view, ought to be considered nearly in the same light as any other articles of merchandize. In consequence of an act of Charles II. coin and bullion are exempt from entry at the custom-house on importation into this kingdom, therefore this article cannot appear in the account of imports, though it is well known, that, besides the bullion used in keeping up or increasing the coin, and in importation and exportation as a merchandize, great quantities are imported as a raw material for the use of our manufactures. The quantity sent out of the country legally is known; the quantity imported must be much greater; but while no account of it is taken the real amount of the imports must be very incomplete, and consequently any conclusions respecting the balance of trade, drawn from such a defective account, may be very erroneous. It cannot be denied, that, if the country derive a profit from its foreign trade, the value of the merchandize and of the coin and bullion imported, must together exceed that of its exports; particularly as it has been shown, that a part of the former is to be considered rather as a remittance of property from abroad to its owners in this country than as a return for exports; it might indeed be otherwise for a short period, from our merchants allowing a longer, or larger, credit to their foreign correspondents; but this would be only a temporary suspension of the returns.

Therefore, as it appears by the Custom-house accounts, that the value of foreign produce and manufactures imported is usually considerably less than that of the exports, it would follow, supposing these valuations were correct, that the difference, together with a sum equal to the whole profits of foreign trade, is annually imported in cash and bullion, which are not included in those accounts. But if this were really the case, our stock of the precious metals, either in the form of bullion, specie, or goods manufactured of gold and silver, must have increased, not only to an amount greater than there is any evidence to prove, but far beyond all probability. In fact, this rapid flow of wealth into the country from foreign trade, which, although certainly great, is probably less than it would appear in the usual way of estimating it, has been almost constantly counteracted in various degrees, by political engagements with other countries, by losses at sea, and many other circumstances, by which wealth is carried out of the country without any advantageous return.

Trade *winds* denote certain regular winds at sea, blowing either constantly the same way, or alternately this way and that; thus called from their use in navigation, and the Indian commerce.

The trade-winds are of different kinds, some blowing three or six months of the year one way, and then the like space of time the opposite way; these are very common in the Indian seas, and are called monsoons.

Others blow constantly the same way; such is that general wind between the tro-

pics, which, off at sea, is found to blow all day long from east to west.

TRADESCANTIA, in botany, *spiderwort*, a genus of the Hexandria Monogynia class and order. Natural order of Ensatæ. Junci, Jussieu. Essential character: calyx three-leaved; petals three; filaments equal with jointed hairs; capsule three-celled. There are nineteen species.

TRAGACANTH. See Gum.

TRAGEDY, a drama which represents some grand and serious action, and which has frequently a fatal issue or end. Its genuine object is to purify and moderate the passions, by exhibiting them in their excess, and to hold forth such a picture of the crimes and miseries of mankind as may teach us, by fear, to be prudent, for our own sake; and, by compassion, to be charitable, for the sake of others. To produce this effect, three principles are essential to tragedy: first, it should represent our fellow-creatures in peril and misfortune; secondly, the peril should inspire us with alarm and dread, and the misfortune should interest and affect us; and, thirdly, the imitation should be conformable to nature and truth; that, while it engages our attention, it may render even the emotions of sorrow pleasing to us. On these principles are founded all the rules which relate to the choice of a subject, to the delineation of characters, and to the composition of the fable, dialogue, and action.

All events and circumstances which seriously influence mankind, and excite the stronger passions, are fit subjects for tragedy. Such, in the language of our great poet, are

"—— The whips and scorns o'th' time;
Th' oppressor's wrong, the proud man's contumely,
The pangs of despis'd love, the law's delay,
The insolence of office, and the spurns
That patient merit of th' unworthy takes."

To these ills men in all conditions are liable, but it is seldom that the poet confines himself to a representation of them in common life, because the vicissitudes incident to greatness afford him wider scope to display them. Hence tragedy, as was before observed, is frequently the imitation of a grand action, involving some important state concern, the fall of a chief, or the acquisition of a crown. Such events naturally rouse the passions of ambition, love, hatred, and revenge; and are calculated more deeply to affect the heart with sentiments of terror and pity. But whatever be the subject, the actual representation of tragic scenes ought never to be carried to excess. Murder and suicide should be banished from the stage, or admitted only in extreme cases, because the terror and the pity which such sights inspire are mingled with a feeling of horror, at which human nature revolts.

Of the rules for the composition of tragedy, the most important are those of the unities. (See Drama.) By the unities of time and place, it is meant, that the story should comprehend no longer a period of time than the representation, or, at most, that it should not exceed four and twenty hours; and that the place of action should never be supposed to change. These rules are insisted on, as necessary to preserve the illusion of the scene; but in many cases they must obviously tend to destroy it. In order to contrive the incidents of a fable to pass within the time prescribed, many important scenes must be related, instead of being represented; and to bring all the persons concerned in the drama to one spot, during that time, many violations of probability must be made. Hence it is, that the regular tragedies of the French school are so barren of incident, and so replete with tedious declamation. The choice of a subject is there controlled by the laws of time and place; whereas the observance of those laws should be regulated by the nature of the subject. Perhaps there is not a more genuine tragedy than Shakspeare's "Lear;" yet how vain would be the attempt to new-model it by the rules, and render it equally sublime and affecting. The powers of the immortal author himself would be inadequate to such a task.

The unity of action alone is in all cases indispensable. A tragedy is something more than a history: it is a tissue of events not merely succeeding each other, but arising out of each other. It is one whole and entire action developed by a series of incidents which sustain it to the end, and which concur all to the same point. If an episode or under-plot is introduced, it must be rendered auxiliary to the main story, so as not to be suppressed without injury to it; otherwise it must necessarily constitute an independent action of itself, and the unity of the subject would be broken.

The exposition, or opening of the fable

was assigned by the ancients to the prologue; with the moderns it is comprehended in the first act. This act should form the basis of the rest, both with regard to the main action, and to the episodes, so that no actor should enter in the subsequent acts, who has not been introduced or mentioned in the first.

By the intrigue is meant that concatenation of facts or incidents, whose perplexity arrests for a time the progress of the action. Thus, the difficulties attending a principal personage in the tragedy, constitute what is properly called the intrigue; and it is this which keeps the spectator in suspense, and gradually raises his curiosity to the highest pitch by the variety of emotions, interests, and passions which it involves. For instance, in the tragedy of "Othello," the circumstances attending the Moor's jealousy strengthen his suspicions by degrees, and render him "perplexed in the extreme." Here lies the intrigue of the piece.

The *denouement* is the unravelling of the intrigue. It ought to arise naturally from what precedes, and should be quite unforeseen, because all interest is sustained by the uncertainty of the mind, between fear and hope. There are instances, however, where the *denouement*, although foreseen, is nevertheless interesting. With regard to what is called poetical justice, we may observe, that although it may be most grateful to behold virtue triumphant and vice disgraced, yet the drama, to be a picture of human life, must sometimes exhibit the reverse; in these cases it will not be without its use, if it direct our view to "something after death."

The division into acts is purely arbitrary, and seems to have been unknown on the Grecian stage. Aristotle makes no such distinction; he speaks only of the duration of the piece, which has naturally only three parts, a beginning, a middle, and an end. Horace insists, that there shall be neither more nor less than five acts; and to this rule most of the moderns have adhered.

Of the style best adapted to tragedy, it were trite to say, that it should be appropriate to the characters. It may be lofty, it may be elegant, but it must always appeal directly to the heart. The most pathetic scenes of our tragic poets are written in language very little elevated above the dialogue of real life, and to this language Shakspeare has, by a combination and a phraseology peculiar to himself, imparted new powers, for he has expressed in it some of the sublimest conceptions of human genius.

TRAGIA, in botany, so named in memory of Hieronymus Tragus, a genus of the Monoecia Triandria class and order. Natural order of Tricoccæ. Euphorbiæ, Jussieu. Essential character: male, calyx three-parted; corolla none: female, calyx five-parted; corolla none; style trifid; capsule tricoccous, three-celled; seeds solitary. There are eight species, natives of the East and West Indies.

TRAGOPOGON, in botany, *goats-beard*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semifloseulosæ. Cichoraceæ, Jussieu. Essential character: calyx simple; down feathered; receptacle naked. There are fourteen species.

TRAJECTORY *of a comet*, is its path or orbit, or the line it describes in its motion. This path is supposed, by Hevelius, to be nearly a right line. Dr. Halley assumes it to be a very eccentric ellipse; but says, it may often be computed on the supposition of its being a parabola. Sir Isaac Newton shows how to determine the trajectory of a comet from three observations. See "Principia," book 3, Prop. 41.

TRAIN, the attendance of a great person, or the trail of a gown, or robe of state. In falconry, it denotes the tail of a hawk.

Train is likewise used for the number of beats which a watch makes in an hour, or any other certain time.

Train is also used for a line of gunpowder, laid to give fire to a quantity thereof, in order to do execution by blowing up earth, works, buildings, &c.

Train, or Traile *of artillery*, includes the great guns, and other pieces of ordnance, belonging to an army in the field. See Cannon.

Train *oil*, the oil procured from the blubber of a whale by boiling. See the articles Oil.

Train *bands*, or Trained *bands*, a name given to the militia of England.

TRAINING, or Tracing, in mineralogy, a term used by the miners, to express the tracing up the mineral appearances on the surface of the earth to their head, or original place, and there finding a mine of the metal they contain.

TRAMEL, an instrument, or device, sometimes of leather, more usually of rope, fitted to a horse's legs, to regulate his mo-

tions, and form him to an amble. It is also taken in many places for an iron moveable instrument in chimnies, to hang pots over the fire.

TRAMEL *net*, is a long net wherewith to take fowl by night, in champaign countries, much like the net used for the low bell, both in shape, bigness, and mashes. To use it, they spread it on the ground, so as the nether, or further end, fitted with small plummets, may lie loose thereon; then the other part, being borne up by men placed at the fore ends, it is thus trailed along the ground. At each side are carried great blazing lights, by which the birds are raised, and as they rise under the net they are taken.

TRAMMELS, in mechanics, an instrument used by artificers for drawing ovals upon boards. It consists, on one part, of a cross with two grooves at right angles; the other is a beam carrying two pins which slide in those grooves, and also the describing pencil. Engines in general, intended for turning ovals, are constructed on the same principles with trammels: the only difference is, that in the trammels the board is at rest, and the pencil moves upon it: in the turning engine, the tool which supplies the place of the pencil is at rest, and the board moves against it. See LATHE, and TURNING.

TRANSACTIONS, *philosophical*, a kind of journal of the principal things that come before the Royal Society of London. See SOCIETY. It appears, that the printing of these transactions was always, from time to time, the single act of the respective secretaries of the Society, till the publication of the 47th volume, in 1753, notwithstanding it has been the common opinion, that they were published by the authority, and under the direction, of the Society itself. The truth is, that the Society, as a body, never did interest themselves further in their publication, than by occasionally recommending the revival of them to some of their secretaries, when, from the particular circumstances of their affairs, the transactions had happened for any length of time to be intermitted, and this seems principally to have been done with a view to satisfy the public, that their usual meetings were then continued for the improvement of knowledge, and benefit of mankind, the great ends of their first institution; but the Society being of late years greatly enlarged, and their communications more numerous, they thought it advisable, that a committee of their members should be appointed to reconsider the papers read before them, and select out of them such as they should judge proper for publication in the future transactions, which was accordingly done upon the 26th of March, 1752.

The transactions are now usually published in half volumes twice a year, and each member is entitled to receive one copy gratis, of every part published after his admission into the Society. The volumes have lately been abridged by Dr. Hutton and others. Those published before the year 1750, were abridged in eleven volumes, quarto, by Mr. Jones, Mr. Eames, and Mr. Martyn.

TRANSCENDENTAL, or TRANSCENDANT, something elevated or raised above other things; which passes and transcends the nature of other inferior things. Transcendental quantities, among geometricians, are indeterminate ones, or such as cannot be fixed or expressed by any constant equation: such are all transcendental curves, which cannot be defined by any algebraic equation; or which, when expressed by an equation, one of the terms thereof is a variable quantity. Now whereas algebraists use to assume some general letters or numbers, for the quantity sought in these transcendental problems, Mr. Leibnitz assumes general or indefinite equations for the lines sought; *e. gr.* putting x and y for the absciss and ordinate, the equation he uses for a line sought, is $a + bx + cy + exy + fxx + gyy$, &c. $= o$, by the help of which indefinite equation, he seeks the tangent; and by comparing the result with the given property of tangents, he finds the value of the assumed letters, a, b, c, d, &c. and thus defines the equation of the line sought.

If the comparison above-mentioned do not proceed, he pronounces the line sought not to be an algebraical, but a transcendental one. This supposed, he goes on to find the species of transcendency: for some transcendentals depend on the general division or section of a ratio, or upon the logarithms; others, upon the arcs of a circle; and others, on more indefinite and compound enquiries. He therefore, besides the symbols, x and y, assumes a third, as v, which denotes the transcendental quantity; and of these three, forms a general equation for the line sought, from which he finds the tangent, according to the differential method, which succeeds even in transcendental quantities. The result he compares with the given properties of the tangent, and so

discovers, not only the values of a, b, c, d, &c. but also the particular nature of the transcendental quantity. And though it may sometimes happen, that the several transcendentals are so to be made use of, and those of different natures too, one from another; also, though there be transcendents of transcendentals, and a progression of these *in infinitum*; yet we may be satisfied with the most easy and useful one, and for the most part, may have recourse to some peculiar artifices for shortening the calculus, and reducing the problem to as simple terms as may be.

This method being applied to the business of quadratures, or to the invention of quadratrices, in which the property of the tangent is always given, it is manifest, not only how it may be discovered, whether the indefinite quadrature may be algebraically impossible; but also, how, when this impossibility is discovered, a transcendental quadratrix may be found, which is a thing not before shown. So that it seems, that geometry, by this method, is carried infinitely beyond the bounds to which Vieta and Des Cartes brought it, since, by this means, a certain and general analysis is established, which extends to all problems of no certain degree, and consequently not comprehended within algebraical equations.

Again, in order to manage transcendental problems, wherever the business of tangents or quadratures occurs, by a calculus, there is hardly any that can be imagined shorter, more advantageous, or more universal, than the differential calculus, or analysis of indivisibles and infinites. By this method we may explain the nature of transcendental lines, by an equation; *e. gr.* let a be the arch of a circle, and x the versed sine; then will $a = \frac{8\,dx}{\sqrt{2x - xx}}$, and if the ordinate of the cycloid be y, then will $y = \sqrt{2x - xx} + \frac{8\,dx}{\sqrt{2x - xx}}$; which equation perfectly expresses the relation between the ordinate, y, and the abscissa, x, and from it all the properties of the cycloid may be demonstrated.

Thus is the analytical calculus extended to those lines which have hitherto been excluded, for no other reason, but that they were thought incapable of it.

TRANSCRIPT, a copy of any original writing, particularly that of an , or instrument, inserted in the body of another.

TRANSFER, in commerce, &c. an act whereby a person surrenders his right, interest, or property, in any thing moveable or immoveable, to another. The term, transfer, is chiefly used for the assigning and making over shares in the stocks, or public funds, to such as purchase them of the proprietors.

TRANSFORMATION, in general, denotes a change of form, or the assuming a new form different from a former one. The chemists were a long time seeking the transformation of metals; that is, their transmutation, or the manner of changing them into gold. See TRANSMUTATION

TRANSFORMATION *of equations*. The doctrine of the transformation of equations, and of exterminating their intermediate terms, is thus taught by Mr. Mac Laurin. The affirmative roots of an equation are changed into negative roots of the same value, and the negative roots into affirmative, by only changing the signs of the terms alternately, beginning with the second. Thus, the roots of the equation, $x^4 - x^3 - 19x^2 + 49x - 30 = 0$, are $+1, +2, +3, -5$; whereas the roots of the same equation, having only the signs of the second and fourth terms changed, *viz.* $x^4 + x^3 - 19x^2 - 49x - 30 = 0$, are $-1, -2, -3, +5$.

To understand the reason of this rule, let us assume an equation, as $\overline{x - a} \times \overline{x - b} \times \overline{x - c} \times \overline{x - d} \times \overline{x - e}$, &c. $= 0$, whose roots are $+a, +b, +c, +d, +e$, &c.; and another, having its roots of the same value, but affected with contrary signs, as $\overline{x + a} \times \overline{x + b} \times \overline{x + c} \times \overline{x + d} \times \overline{x + e}$, &c. $= 0$. It is plain, that the terms taken alternately, beginning from the first, are the same in both equations, and have the same sign, being products of an even number of the roots, the product of any two roots having the same sign as their product when both their signs are changed, as $+a \times -b = -a \times +b$.

But the second terms, and all taken alternately from them, because their coefficients involve always the products of an odd number of the roots, will have contrary signs in the two equations. For example: the product of four, *viz.* $abcd$, having the same sign in both, and one equation in the fifth term having $abcd \times +e$, and the other $abcd \times -e$, it follows, that their product, $abcde$, must have contrary signs in the two equations: these two equations, therefore, that have the same roots, but with contrary signs, have nothing different

but the signs of the alternate terms, beginning with the second. From which it follows, that if any equation is given, and you change the signs of the alternate terms, beginning with the second, the new equation will have roots of the same value, but with contrary signs.

TRANSIT, in astronomy, signifies the passage of any planet, just by, or over a fixed star, or the sun, and of the moon in particular, covering or moving over any planet. See VENUS.

TRANSITION, in rhetoric, is of two sorts. The first is when a speech is introduced abruptly without express notice given of it, as when Milton gives an account of our first ancestors evening devotions.

"Both turn'd, and under open sky ador'd
The God that made both air, sky, earth
and heaven.—
—— Thou also mad'st the night,
Maker omnipotent, and thou the day!"

The second sort of transition is, when a writer suddenly leaves the subject he is upon, and passes unto another, from which it seems different at first view, but has a relation and connection with it, and serves to illustrate and enlarge it.

TRANSITIVE, in grammar, an epithet applied to such verbs as signify an action which passes from the subject that does it, to or upon another subject which receives it. Under the head of verbs transitive, come what we usually call verbs active and passive, other verbs, whose action does not pass out of themselves, are called neuters, and by some grammarians, intransitives.

TRANSMISSION, in optics, &c. the act of a transparent body passing the rays of light through its substance, or suffering them to pass in which sense the word stands opposed to reflection. Transmission is also frequently used in the same sense with refraction, by which most bodies, in transmitting the rays, do also refract them. For the cause of transmission, or the reason why some bodies transmit, and others reflect the rays. See OPACITY.

TRANSMUTATION, the act of transforming, or changing one nature into another. Nature, Sir Isaac Newton observes, seems delighted with transmutations: he goes on to enumerate several kinds of natural transmutations, gross bodies, and light, he suspects, may be mutually transmuted into each other; and adds, that all bodies receive their active force from the particles of light, which enter their composition. For all fixed bodies, when well heated, emit light as long as they continue so, and again, light intermingles itself, and inheres in bodies, as often as its rays fall on the solid particles of those bodies. Again, water, which is a fluid, volatile, tasteless salt, is by heat transmuted into a vapour, which is a kind of air, and by cold, into ice, which is a cold transparent brittle stone, easily dissolvable, and this stone is convertible again into water by heat, as vapour is by cold.

TRANSMUTATION, in alchemy, denotes the art of changing or exalting imperfect metals into gold or silver. This is also called the grand operation, and, they say, is to be effected with the philosopher's stone. See ALCHEMY.

TRANSMUTATION, in geometry, denotes the reduction or change of one figure or body into another of the same area or solidity, but of a different form: as a triangle into a square, a pyramid into a parallelopiped, &c. In the higher geometry, transmutation is used for the converting a figure into another of the same kind and order, whose respective parts rise to the same dimensions in an equation, admit of the same tangents, &c. If a rectilinear figure be transmitted into another, it is sufficient that the intersections of the lines which compose it be transferred, and the lines drawn through the same in the new figure. If the figure to be transmuted be curvilinear, the points, tangents, and other right lines by means whereof the curve line is to be defined, must be transferred.

TRANSOM, among builders, denotes the piece that is framed across a double light window.

TRANSOM, among mathematicians, signifies the vane of a cross-staff, or a wooden number fixed across, with a square whereon it slides, &c.

TRANSOM, in a ship, a piece of timber which lies athwart the stern, between the two fashion pieces, directly under the gun-room port.

TRANSPARENCY, in physics, a quality in certain bodies whereby they give passage to the rays of light, in contradistinction to opacity, or that quality of bodies which renders them impervious to the rays of light. See OPACITY.

TRANSPOSITION, in algebra, the bringing any term of an equation over

to the other side. See ALGEBRA and EQUATION.

TRAPA, in botany, *water caltrops*, a genus of the Tetrandria Monogynia class and order. Natural order of Hydrocharides, Jussieu. Essential character: calyx four-parted; corolla four-petalled; nut girt with four opposite spines, which were the leaves of the calyx. There are two species, *viz.* T. natans, four-horned water caltrops; and T. biconis, two-horned water caltrops.

TRANSVERSE, something that goes across another, from corner to corner: thus bends and bars, in heraldry, are transverse pieces or bearings: the diagonals of a parallelogram or a square, are transverse lines: lines which make intersections with perpendiculars, are also called oblique or transverse lines.

TRAP, in mineralogy, is a Swedish term signifying stair. It was first applied to designate a certain class of mountains, composed of nearly horizontal strata, with perpendicular breaks, which were supposed to give a rude resemblance to a flight of stairs. Hence many species of rock, differing very much from each other, were called by the same name, which caused much confusion. According to Werner, there are three distinct classes or formations of rocks to which the term trap may be applied: of these the first class belongs to the primitive mountains, the second to the transition mountains, and the third to the secondary mountains. Primitive traps are composed essentially of hornblende, mingled with felspar, and sometimes with pyrites and mica. Of rocks belonging to this formation there are four distinct species, *viz.* the common hornblende, the schistose hornblende, primitive grünstein, and schistose grünstein. Transition traps are composed principally of granular grünstein, but the mixture of the ingredients is more intimate, the grain is finer, and the mass appears more homogeneous. There are two principal varieties, *viz.* 1. The amygdaloid, which is a rock of schistose hornblende in a state of semi-decomposition resembling fine ferruginous clay. It contains a number of globular cavities, from the size of a pea to that of a small apple: of these cavities some contain nothing but air, and are coated on the inside with a kind of varnish; others contain balls of calcareous spar, quartz, chalcedony, &c. The toadstone of Derbyshire is considered by Werner as belonging to this variety. 2. Globular trap, composed of schistose grünstein, in a state of semi-decomposition, arranged in spheroids of various magnitudes, and composed of thick concentric lamellar distinct concretions. Secondary or floetz traps are divided into those which are peculiar and characteristic of it, and those which are accidental. The former are basalt, porphyry, &c. Among the latter may be classed rubble and sandstone, clay, coal, and bituminous wood. The proper base to the secondary trap formation, or in other words the substance, which appears to have immediately preceded it in the order of formation, is secondary limestone; it is not, however, not unfrequently found resting on sandstone, on argillite, on gneiss, and even on granite. The general order in which the strata of this formation, is the following, *viz.* coarse sand, fine sand, sandy clay, unctuous clay, wakke, basalt, amygdaloid, porphyry, and grünstein. It hardly ever happens that all these strata are met with in the same mass of mountain. No metallic veins are found in this class of mountains, but the remains of vegetable and marine organized bodies are of frequent occurrence. See ROCK.

TRAPEZIUM, in geometry, a plane figure contained under four unequal right lines. 1. Any three sides of a trapezium taken together, are greater than the fourth. 2. The two diagonals of any trapezium, divide it into four proportional triangles. 3. If two sides of a trapezium be parallel, the rectangle under the aggregate of the parallel sides and one half their distance is equal to that trapezium. 4. If a parallelogram circumscribes a trapezium, so that one of the sides of the parellelogram be parallel to a diagonal of the trapezium, that parallelogram will be the double of the trapezium. 5. If any trapezium has two of its opposite angles, each a right angle, and a diagonal be drawn joining these angles; and if from the other two angles be drawn two perpendiculars to that diagonal, the distances from the feet of these perpendiculars to those right angles, respectively taken, will be equal. 6. If the sides of a trapezium be each bisected, and the points of bisection be joined by four right lines, these lines will form a parallelogram, which will be one half of the trapezium. 7. If the diagonals of a trapezium be bisected, and a right line joins these points, the aggregate of the squares of the sides is equal to the aggregate of the squares of the diagonals, together with four times of the square of the right line joining the point of bisec-

tion. 8. In any trapezium, the aggregate of the diagonals is less than the aggregate of four right lines drawn from any point (except the intersection of the diagonals) within the figure.

TRAVELLER, in naval affairs, one or more iron thimbles, with a rope spliced round them, sometimes forming a kind of tail, but more generally a species of grommet, and used on various occasions.

TRAVERSE, or TRANSVERSE, in general, denotes something that goes athwart another; that is, crosses and cuts it obliquely.

Hence, to traverse a piece of ordnance, among gunners, signifies to turn or point it which way one pleases, upon the platform.

In fortification, traverse denotes a trench with a little parapet, or bank of earth, thrown perpendicularly across the moat, or other work, to prevent the enemy's cannon from raking it. These traverses may be from twelve to eighteen feet, in order to be cannon proof, and their height about six or seven feet, or more, if the place be exposed to any eminence.

TRAVERSE, in navigation, is a compound course, wherein several different successive courses and distances are known. To work a traverse, or to reduce a compound course to a single one, 1. Make a table of six columns, marked, course; distance; N.S.E.W. beginning at the left hand, and write the given courses and distances in their proper columns. 2. Seek the given courses and distances in the traverse table, and let the corresponding differences of latitude and departure be written in their proper columns in the table made for the question. 3. Add up the columns of northing, southing, easting, and westing; then the difference between the sums of northing and southing gives the whole difference of latitude, which is of the same name with the greater; and the difference between the sums of easting and westing will be the whole departure, which is likewise of the same name with the greater. 4. The whole difference, latitude, and departure to the compound course being found, the direct course and distance will be found by Case IV. of plain-sailing. See NAVIGATION, &c.

TRAVERSE, in law, signifies sometimes to deny, sometimes to overthrow or undo a thing, or to put one to prove some matter; much used in answers to bills in chancery; or it is that which the defendant pleads, or says, in bar, to avoid the plaintiff's bill, either by confessing and avoiding, or by denying and traversing the material parts thereof. Traverse is also to take issue upon the chief matter, and to contradict or deny some point of it. To traverse an office, is to prove that an inquisition made of lands or goods, by escheator, is defective and untruly made.

TREASON, in law, is divided into high treason and petty treason. High treason is defined to be an offence committed against the security of the King or kingdom, whether it be by imagination, word, or deed; as to compass or imagine the death of the King, Queen, or Prince, or to deflower the King's wife, or his eldest daughter unmarried; or his eldest son's wife; or levy war against the King in his realm, adhere to his enemies, counterfeit his great seal, privy seal, or money, or wittingly to bring false money into this realm, counterfeited like the money of England, and utter the same; to kill the King's Chancellor, Treasurer, Justices of either bench, Justices in Eyre, of Assize, or of Oyer and Terminer, being in their place doing this office; forging the King's sign manual or privy signet, privy seal, or foreign coin current here, or diminishing or impairing current money. In case of treason, a man shall be drawn, hanged, and quartered, and forfeit his lands and goods to the King. 25 Edward III.

TREASON, *petit*. Whenever a wife murders her husband, a servant his master or mistress, or an ecclesiastic a prelate, or to whom he owes obedience, every one of these offences is petit treason.

As every petit treason implies a murder, it follows, that the mere killing of an husband, master, or prelate, is not always petit treason; for if there are not such circumstances in the case of killing one of these persons, as would have made it murder in the case of killing any other person, it does not amount to this offence.

There can be no accessary in high treason. And it seems to be always agreed, that what would have made a man an accessary before the fact in any other felony, makes him a principal in high treason.

As the person of his Majesty was imagined in imminent danger, it was thought necessary to enact two late statutes, viz. 36 George III. c. 7, and 36 George III. c. 8; the former to enlarge the clauses in the statute 25 Edward III. for the greater safety of his Majesty's person; the latter for the preventing seditious meetings. But

on account of the too great length of the acts we are obliged to refer the reader to them. There is nothing so dangerous, in a constitutional point of view, as what are called constructive treasons, by which persons are held guilty of treason, upon something constructively deemed dangerous to the safety of the King.

TREASURE *trove*, is where any money or coin; gold, silver, plate, or bullion, is hidden in the earth, or other private place, the owner thereof being unknown; in which case, the treasure belongs to the King, or some other who claims by the King's grant, or by prescription. But if he that hid it be known, or afterwards found out, the owner and not the King is entitled to it. If it be found in the sea, or upon the earth, it doth not belong to the King but to the finder, if no owner appear.

TREASURER, an officer to whom the treasure of a prince, or corporation, is committed to be kept, and duly disposed of. The Lord High Treasurer of Great Britain or first Commissioner of the Treasury, when in commission, has under his charge and government all the King's revenue, which is kept in the Exchequer. He holds his place during the King's pleasure, being instituted by the delivery of a white staff to him: he has the check of all the officers employed in collecting the customs and other royal revenues; and in his gift and disposition are all the offices of the customs in the several ports of the kingdom; escheators in every county are nominated by him; he also makes leases of the lands belonging to the crown. There is, besides the Lord Treasurer, a Treasurer of the King's Houshold, who is of the Privy Council, and, with the Comptroller and Steward of the Marshalsea, has great power. To these may be added the Treasurer of the navy; as also the Treasurer of the King's Chamber, and of the wardrobe; and most corporations throughout the kingdom have treasurers, whose office is to receive their rents, and disburse their common expences. The Treasurer of the County, is an officer that keeps the county-stock, in which office there are two in every county; who are chosen by the major part of the justices of the peace at Easter-sessions. They ought to have certain estates in lands, or to be worth 150*l.* in personal estate, and are to continue in their office only for a year, at the end whereof, or within ten days after the expiration of the year, they must account to their successors, under certain penalties. The county-stock which this officer has the keeping of, is raised by rating every parish annually; and the same is from time to time disposed of to charitable uses, towards the relief of maimed soldiers and mariners, prisoners in the county gaols, paying the salaries of governors of houses of correction, and relieving poor alms-houses, &c.

TREES. See TIMBER.

TREMOLITE, in mineralogy, is a species of the Talc genus, of which there are three sub-species, *viz.* the asbestos; the common; and the glassy; the colours of the last are yellowish, reddish, grey, and green; it occurs massive and crystallized; it is easily frangible and not very heavy; its constituent parts are

Silica	65.00
Magnesia	10.33
Lime	18.00
Oxide of iron	0.16
Water and carbonic acid	6.50
	99.99

It is said to emit a phosphoric light when rubbed in the dark. Before the blow-pipe it melts without addition into a cellular white coloured scoria. It is found principally in primitive mountains, and is there usually imbedded in limestone; it is found in many parts of Germany, in the Shetland islands, and in the basaltic rock on which the castle of Edinburgh is built.

TRENCHES, in fortification, are ditches cut by the besiegers, that they may approach more securely to the place attacked; whence they are also called lines of approach. The tail of the trench is the place where it was begun, and its head is the place where it ends. The trenches are usually opened, or begun, in the night-time; sometimes within musket shot, and sometimes within half or whole cannon shot of the place. They are carried on in winding-lines, nearly parallel to the works of the fortress, so as not to be in the view of the enemy, nor exposed to the enemy's shot. The workmen exployed in the trenches are always supported by a number of troops, to defend them against the sallies of the besieged; the pioneers sometimes work on their knees, and are usually covered with mantlets or faucissons; and the men who support them lie flat on their faces, in order to avoid the enemy's shot.

TRESPASS, is any transgression of the law, under treason, felony, or misprision of

either. Trespass signifies going beyond what is lawful; hence it follows, that every injurious act is, in the large sense of this word, a trespass. But as many injurious acts are distinguished by particular names, as treason, murder, rape, and other names, the legal sense of the word trespass is confined to such injurious acts as have not acquired a particular name. Some trespasses are not accompanied with any force; a trespass of this sort is called a trespass upon this case; and the proper remedy for the party injured, is by an action upon the case. Other trespasses are accompanied with force, either actual or implied. If a trespass, which was accompanied with either actual or implied force, have been injurious to the public, the proper remedy in every such case is by an indictment, or by information. And if a trespass that was accompanied with an actual force, have been injurious only to one or more private persons, the offender is in every such case liable to an indictment, or to an information; for although the injury has in such case been only done to one or more private persons, as every trespass accompanied with actual force is a breach of the peace, it is to be considered and punished as an offence against the public.

A man is answerable for not only his own trespass, but that of his cattle also. And the law gives the party injured a double remedy in this case, by permitting him to distrain the cattle, thus doing damage, till the owner shall make him satisfaction. And in either of these cases of trespass committed on another's land, either by a man himself or his cattle, the action that lies is the action of trespass, with force and arms; for the law always couples the idea of force with that of intrusion upon the property of another. In some cases trespass is justifiable; or rather entry on another's land or house shall not in these cases be accounted trespass; as if a man came there to demand or pay money there payable, or to execute in a legal manner the process of the law. To prevent trifling and vexatious actions of trespass, it is enacted, by 43 Eliz. c. 6, 22 and 23 Charles II. c. 9, and 8 and 9 William c. 2, that where a jury who try an action of trespass give less damages than 40s. the plaintiff shall be allowed no more costs than damages, unless the judge shall certify on the back of the record, that the freehold or title of the land came chiefly in question. But if it shall appear, that the trespass was wilful and malicious, the plaintiff shall have his full costs. And every trespass is wilful, where the defendant has been forewarned; and malicious, where the intent of the defendant appears to be to harass or injure the plaintiff.

TRET, in commerce, an allowance made for the waste, or the dirt, that may be mixed with any commodity, which is always four pounds in every one hundred and four pounds weight. See TARE.

TREWIA, in botany, a genus of the Monoecia Polyandria class and order. Essential character: calyx three-leaved, superior; corolla none; capsule tricoccous. There is only one species, viz. T. nudiflora; this is a lofty tree, with a thick trunk, covered with an ash-coloured bark; leaves on long round petioles, oblong, ovate, cordate, attenuated at the point; dusky green on the upper surface, but brighter on the lower; flowers on round pale green peduncles, axillary, of an herbaceous colour, void of scent. Native of the East Indies.

TRIAL, the proceeding of a court of law, when the parties are at issue, such as the examination of witnesses, &c. to enable the court, deliberately weighing the evidence given on both sides, to draw a true conclusion, and administer justice accordingly.

TRIANDRIA, in botany, the name of the third class in the Linnæan system, consisting of plants with hermaphrodite flowers, which have three stamina or male organs. There are three orders in this class derived from the number of styles.

TRIANGLE, in geometry, a figure of three sides and three angles. Triangles are either plane or spherical. A plane triangle is contained under three right lines; and a spherical one is a triangle contained under three arches of great circles of the sphere. Triangles are denominated, from their angles, right, obtuse, and acute. A right-angled triangle is that which has one right angle. An obtuse-angled-triangle is such as has one obtuse angle. And an acute-angled triangle is that which has all its angles acute.

In every triangle the sines of the sides are proportional to the sines of the opposite angles; also the sine of all the three angles is equal to two right ones; and the external angle, made by any side produced, is equal to the sum of the two internal and opposite angles. Triangles on the same base, and having the same height or place, between the same parallels, are equal; also triangles on equal bases, and between the

same parallels, are equal. If a perpendicular be let fall upon the base of an oblique-angled triangle, the difference of the squares of the sides is equal to the double-rectangle under the base, and the distance of the perpendicular from the middle of the base. The side of an equilateral triangle, inscribed in a circle, is in power triple of the radius. The sides of a triangle are cut proportionably, by a line drawn parallel to its base. A whole triangle is to a triangle cut off by a right line drawn parallel to the base, as the rectangle under the cut sides is to the rectangle of the two other sides. In a right-angled triangle, a line drawn from the right-angle at the top, perpendicular to the hypothenuse, divides the triangle into two other right-angled triangles, which are similar to the first triangle, and to one another. In every right-angled triangle, the square of the hypothenuse is equal to the sum of the squares of the other two sides; and, in general, any figure described on the hypothenuse, is equal to the sum of two similar figures described upon the two sides. In an isosceles triangle, that is a triangle having two of its sides equal, if a line be drawn from the vertex to any point in the base; the square of that line together with the rectangle of the segments of the base, is equal to the square of the side. If one angle of a triangle be equal to 120°; the square of the base will be equal to the squares of both sides, together with the rectangle of those sides; and if those sides be equal to each other, then the square of the base will be equal to three times the square of one side, or equal to twelve times the square of the perpendicular from the angle upon the base.

If any angle of a triangle be bisected, the bisecting line will divide the opposite side in the same proportion as the legs of the angle are to one another. Every triangle is one half of a parallelogram of the same base and height. The area of any triangle may be had by adding all the three sides together, and taking half the sum, and from that half subtracting each side severally, and multiplying that half sum and the remainder continually into one another, and extracting the square root of the product. See TRIGONOMETRY.

TRIANGLE, in astronomy, one of the forty-eight ancient constellations, situated in the northern hemisphere. There is also a southern triangle, in the other hemisphere. According to the British catalogue, there are sixteen stars in the northern; and in Sharp's catalogue there are five in the southern triangle.

TRIANGULAR *compasses*, are such as have three legs, or feet, whereby to take off any triangle at once; much used in the construction of maps, globes, &c.

TRIANGULAR *numbers*, are a kind of polygonal numbers, being the sums of arithmetical progressions, the difference of whose terms is 1.

Thus from the arithmetical numbers 1, 2, 3, 4, 5, 6, are formed the triangular numbers 1, 3, 6, 10, 15, 21. The sum of any number n of the terms of the said triangular numbers is $= \frac{n}{1} \times \frac{n+1}{2} \times \frac{n+2}{3}$; if n be 5, the sum will be 35, which is also equal to the sum of the number of shot in a triangular pile of balls, the number of rows, or the number in each side of the base being n. The sum of the reciprocals of the triangular series infinitely continued is equal to $2 = 1 + \frac{1}{3} + \frac{1}{6} + \frac{1}{10}$, &c.

TRIANGULAR *canon*, the tables of artificial sines, tangents, secants, &c.

TRIANGULAR *quadrant*, is a sector furnished with a loose piece, whereby to make it an equilateral triangle.

The calendar is graduated thereon, with the sun's place, declination, and other useful lines; and by the help of a string and a plummet, and the divisions graduated on the loose piece, it may be made to serve for a quadrant.

TRIANTHEMA, in botany, a genus of the Decandria Digynia class and order. Natural order of Succulentæ. Portulaceæ, Jussieu. Essential character: calyx mucronate below the tip; corolla none; stamina five or ten; germ retuse; capsule cut round. There are seven species.

TRIBOMETER, a term applied by Muschenbroek and others to an instrument invented for measuring the friction of metals. It consists of an axis formed of hard steel, passing through a cylindrical piece of wood; the ends of the axis, which are highly polished, are made to rest on the polished semicircular cheeks of various metals, and the degree of friction is estimated by means of a weight suspended by a fine silken string or ribband over the wooden cylinder.

TRIBULUS, in botany, *caltrops*, a genus of the Decandria Monogynia class and order. Natural order of Gruinales. Rutaceæ, Jussieu. Essential character: calyx five-parted; petals five, spreading; style none;

capsule five, gibbous, spiny, many-seeded. There are four species.

TRICERA, in botany, a genus of the Monoecia Tetrandria class and order. Natural order of Tricoccæ. Euphorbiæ, Jussieu. Essential character: male, calyx four-leaved; corolla none; filaments ovate: female, calyx five-leaved; corolla none; styles conical; capsule three-horned, three-celled. There is only one species, viz. T. lævigata, a native of Jamaica, in mountain coppices in the western parts of the island, flowering in the spring months.

TRICHECUS, the *walrus*, in natural history, a genus of Mammalia of the order Bruta. Generic character: no fore-teeth in the full grown animal, above or below; tusks in the upper jaw solitary; grinders with wrinkled surfaces; body oblong; lips doubled; hind feet stretched, uniting into a fin. These animals are all natives of the sea, and feed on sea-weeds and shell-fish, but are never known to eat flesh. There are three species, of which the principal is T. rosmarus, the arctic walrus, or the morse. This is an animal of a very inelegant structure. It has a small head to a vast body. Its under lip is covered with bristles nearly of the thickness of a crow-quill. In its upper jaw it has two large tusks from one to two feet in length, and weighing from three to twenty pounds. The walrus sometimes grows to the length of eighteen feet, and the circumference, about the thickest part, of twelve. It is principally found in the high latitudes of the Northern Ocean. These animals are gregarious, and are often seen upon floating masses of ice, in immense numbers, the greater part sleeping, but some always on the watch to give notice of approaching danger. They are harmless when not provoked, but some accounts represent them as highly formidable in a state of irritation, the efforts of many being combined against the enemy, and fastening with their teeth against boats to make holes in them, or draw them to the bottom. Others represent them as less agitated by the fury of passion, and as inclined more to flight than revenge, adding, that they are terrified by the slightest flash, and even the pointing of a musket will drive them in a moment out of sight. Their tusks serve the purposes of aiding their movements upon the ice, into which they are stuck, and on which they thus secure their hold and sometimes drag on their unwieldy bodies. The tusks are convertible to the purposes of ivory, and these animals are destroyed for the profit derivable partly from these tusks, but principally for the sake of their oil, of which a full grown walrus will yield a butt. The skin may be manufactured into a very strong leather. The affection between the female and its young one, for it has seldom more than one at a birth, is such that they are said never to separate, and that when one is killed the survivor refuses to quit the dead body, and is considered by the hunter as his secure prey. The walrus has been called, with little resemblance to justify the name, the sea-horse; it is more similar to a cow, but most of all to a seal. See Mammalia, Plate XXI. fig. 3.

T. borealis, or the whale-tailed manati, inhabits the seas between Kamtschatka and America. These animals live in families, generally consisting of a male and female, and two young ones of different ages, and the attachment of the male to the female is so great, that he will defend her when attacked to the last extremity; and if she happens to be destroyed and dragged to the shore, he will swim for some days off the fatal and detested spot. The manati approaches very nearly to the cete tribe, and its feet are little more than pectoral fins. It attains the immense length of twenty-seven feet, and the weight of four tons. In winter it is extremely lean, and its ribs may be distinctly numbered. It will, when pierced with the harpoon, sometime adhere to rocks with its feet with uncommon tenacity, and when forced from them by a cord drawn by thirty men or more, is found to have left part of the skin of the feet behind. When any individual is harpooned, others are stated to swim to its aid, endeavouring, some to overturn the boat, others to break the cord, and others again by blows with their tails, striving to dislodge the harpoon. Their sounds somewhat resemble the snorting of a horse. They are never seen on land.

TRICHILIA, in botany, a genus of the Decandria Monogynia class and order. Natural order of Trihilatæ. Meliæ, Jussieu. Essential character: calyx mostly five-toothed; petals five; nectary toothed, cylindrical, bearing the anthers at the top of the teeth; capsule three-celled, three-valved; seeds buried. There are twelve species.

TRICHIURUS, the *trichiure*, in natural history, a genus of fishes of the order Apodes. Generic character: head lengthened; the gill-covers lateral; teeth ensiformed,

and hooked on one side; gill membrane, seven-rayed; body compressed and ensiform; tail subulate, and without fins. There are two species. T. argenteus, or the silver trichiure, is about two feet and a half long, and inhabits the lakes and rivers of South America, and of some parts of Asia. Its colour of a bright silver; its body tapers gradually, and terminates in an absolute point; its dorsal fin extends nearly through the animal's whole length. It is a fish remarkable for its voracity, and has been known to leap into boats in quest of prey. It is used for the table. The T. electricus is of the same size with the former; but differs in several circumstances relating to the teeth, jaws, and tail. It is supposed to possess an electrical power.

TRICHOCARPUS, in botany, a genus of the Polyandria Digynia class and order. Essential character; calyx four or five-parted; corolla none; styles two, bifid; capsule bristly, four-valved, many-seeded. There is only one species, viz. T. laurifolia, a native of the woods of Guiana.

TRICHOCEPHALUS, in natural history, a genus of the Vermes Intestina class and order. Body round, elastic, and variously twisted; head or fore-part much thicker, and furnished with a slender exsertile proboscis; tail or lower part long, capillary, and tapering to a point. There are six species enumerated, and named from the animals in which they are found: T. hominis inhabits the intestines of sickly children, generally the cœcum, and in considerable numbers; it is usually about two inches long, and in colour it resembles the ascarides. The head is obtuse and furnished with a very slender proboscis, which it can eject or retract at pleasure; tail, or thinner part, twice as long as the thicker end, and terminating in a fine hair-like point. T. equi found in the intestines of the horse; there are others found in the intestines of the boar, fox, mouse, &c.

TRICHODA, in natural history, a genus of the Vermes Infusoria. Worm invisible, pellucid, hairy, or horned. There are seventy or eighty species in sections. A. hairy. B. furnished with cirri. C. horned.

TRICHOMANES, in botany, a genus of the Cryptogamia Filices class and order. Natural order of Filices or Ferns. Generic character: fructifications inserted into the margin of the frond, separate; involucres urn shaped, undivided, opening outwards; columns extending beyond the involucres, like styles. There are twenty-seven species, chiefly natives of the West Indies.

TRICHOSANTHES, in botany, a genus of the Monoecia Syngenesia class and order. Natural order of Cucurbitaceæ. Essential character: calyx five-toothed; corolla five-parted, ciliate: male, filaments three: female, style trifid; pome oblong. There are seven species.

TRICOSTEMA, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ or Labiatæ. Essential character: corolla, upper lip sickle shaped; stamina very long. There are three species.

TRIDAX, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: calyx imbricate, cylindrical; corollets of the ray three-parted; down many rayed, simple; receptacle chaffy. There is only one species, viz. T. procumbens.

TRIENS, in antiquity, a copper money of the value of one-third of an *as*, which on one side bore a Janus's head, and on the other a water-rat.

TRIENTALIS, in botany, a genus of the Heptandria Monogynia class and order. Natural order of Rotaceæ. Lysimachiæ, Jussieu. Essential character: calyx seven leaved; corolla seven parted, equal, flat; berry juiceless. There is but one species, viz. T. Europæa, chick weed winter green.

TRIFOLIUM, in botany, *trefoil*, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: flowers in a head; legume scarcely longer than the calyx; nectary opening, deciduous. There are fifty-one species. T. officinale or melilot, has naked racemous pods, dispermous, wrinkly, and acute, with an erect stalk. It grows in corn-fields, and by the way-sides, but is not common. The stalk is erect, firm, striated, branched, and two or three feet high; the leaves ternate, smooth, obtusely oval, and serrated; the flowers are small, yellow, pendulous, and grow in long close spikes at the tops of the branches; the pod is very short, turgid, transversely wrinkled, pendulous, and contains either one or two seeds. The plant has a very peculiar strong scent, and disagreeable, bitter, acrid taste, but such, however, as is not disagreeable to cattle. The flowers are sweet-scented. It communicates a loathsome flavour to wheat and other grain, so as to render it unfit for making bread. T. repens, white creeping trefoil, or Dutch clover, has a creeping stalk, its flower gathered into an umbellar

head, and its pods tetraspermous. It is very common in fields and pastures. It is well known to be excellent fodder for cattle; and the leaves are a good rustic hygrometer, as they are always relaxed and flaccid in dry weather, but erect in moist or rainy. T. pratense, purple or red clover, is distinguished by dense spikes, unequal corollas, by bearded stipulas, ascending stalks, and by the calyx having four equal teeth. The red clover is common in meadows and pastures, and is the species which is generally cultivated as food for cattle. It abounds in every part of Europe, in North America, and even in Siberia. It delights most in rich, moist, and sunny places, yet flourishes in those that are dry, barren, and shady. See HUSBANDRY.

TRIGLA, the *gurnard*, in natural history, a genus of fishes of the order Thoracici. Generic character: head large, mailed, and marked with rough lines; eyes large; nostrils double; gill covers spiny; gill membrane seven-rayed; before the pectoral fins of most species there are articulate processes, somewhat like fingers. There are fourteen species. T. gurnardus, or the grey gurnard, varies in length from one to two feet; feeds on worms and insects; inhabits the seas of Europe, and the coasts of this island, and is considered by many as excellent for the table, though generally not in high estimation. T. volitans, or the flying gurnard, is found in the Indian, Atlantic, and Mediterranean seas. It is about a foot in length, and its pectoral fins are of an extraordinary size, and great transparency. By these it is enabled to sustain short flights out of the water, when hardly pressed by its various enemies.

TRIGLOCHIN, in botany, *arrow-grass*, a genus of the Hexandria Trigynia class and order. Natural order of Tripetaloideæ. Junci, Jussieu. Essential character: calyx three-leaved; petals three, calyx form; style none; capsule opening at the base. There are three species.

TRIGONELLA, in botany, *fenu-greek*, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: banner and wings nearly equal, spreading in form of a three-petalled corolla. There are twelve species.

TRIGONIA, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Malpighiæ, Jussieu. Essential character: calyx five-parted; petals five, unequal, uppermost foveolate at the base within; nectary, two scales at the base of the germ; filaments, some barren; capsule leguminose, three-cornered, three-celled, three-valved. There are two species: viz. T. villosa, and T. lævis; both natives of South America.

TRIGONOMETRY. The business of this important science is to find the angles where the sides are given; and the sides, of their respective ratios, when the angles are given; and to find sides and angles, when sides and angles are partly given. To effect this, it is necessary not only that the peripheries of circles, but also certain right lines in and about circles, be supposed divided into certain numbers of parts. The ancients, feeling the necessity of such a pre-division, portioned the circle into 360 equal parts, which they called degrees; each degree was again divided into 60 equal parts, called minutes; and each minute comprised 60 equal parts, called seconds. The moderns have improved upon this division by the addition of anonius, or vernier, which may be carried to any extent, but is usually limited to decimating the seconds; noting each tenth part thereof. It would have been found a considerable convenience in mathematics, if the circle had been divided into centisimal parts, particularly in trigonometrical operations; thus making every quadrant to consist of 100 degrees, each degree of 100 minutes, and each minute of 100 seconds: there can, indeed, be no doubt but all the arithmetical calculations relating to the periphery, as well as to the secants, sines, tangents, radii, chords, and complements, would by this reformation have been simplified.

We shall be brief on this head, because it would require more space than could be allotted to any one branch of science, were we to follow the whole extent of trigonometry in this place. The following definitions will be found useful: 1. The complement of an arc is the difference thereof from a quadrant; thus, if an arc measures 60°, the complement is 30°. 2. A chord, or subtense, is a right line drawn from one to the other end of an arc. 3. The sine, or right sine, of an arc, is a perpendicular falling from one end of an arc to the radius drawn, at right angles thereto, towards the other end of the arc. Hence it is clear that an arc of 60° must have its secant, its radius, and its chord, all of the same length, forming an equilateral triangle. The secant and radius both proceed from the centre, but all sines are parallel to a vertical line pass-

ing through the centre, and invariably fall upon a diameter, drawn perpendicular to that right line. See DIALLING, GEOMETRY, and MATHEMATICAL *instruments*; under which various explanations will be found, whereby the student may perceive the necessity for such reference.

The solution of the several cases in plane trigonometry depend upon four propositions, called axioms, which cannot be too perfectly understood, and ought ever to be adverted to.

Axiom I. In any right-lined plane triangle, if the hypothenuse (or longest side) be made the radius of a circle, the other two sides, or legs, will be the sines of their opposite angles: but if either of the legs, including the right angle, be made radius, the other leg becomes the tangent of its opposite angle, and the hypothenuse the secant of the same angle. For in the triangle A B C, (fig. 21. Plate XV. Trigonometry) let A B be made the radius of a circle; and with one foot of the compasses on A or B describe a circle: it is plain that the leg B C will be the sine of the angle A, and A C the sine of the angle B: but if A C becomes radius, B C will be the tangent to the angle A, and B A the second thereto. Again, by making B C radius, A C will be tangent, and A B the secant of the angle B. Hence it is plain that the different sides take their names according to that side which is made radius.

Remark, that to find a side, any side may be made radius: then say, as the name of the side given is to the name of the side required; so is the side given to the side required. But to find an angle, one of the given sides must be made radius: then, as the side made radius is to the other side; so is the name of the first side (which is always radius) to the name of the second side; which fourth proportional must be found among the sines, or tangents, &c. to be determined by the side made radius: against it is the required angle. In a right-angled triangle you must always have two sides, or the angles and one side given to find the rest.

Axiom II. In all plane triangles, the sides are in direct proportion to the sines of their opposite angles. Thus, "if two angles and one side be given to find either of the other legs." In fig. 22. the angle B C D is 101° 25′, the angle C B D is 44° 42′, and the given leg B C is equal to 76 of the scale assumed: to find the sides C D and B D.

To find D C.

As the sine angle D 101° 25′.......	9.99132
Is to the side B C 76..................	1.88081
So is sine angle B 44° 42′............	9.84720
	11.72801
	9.99132
To the side D C 54.53..............	1.73669

The foregoing is worked by logarithms, thus: add the logarithm of the second and third terms together, then deduct the logarithm of the first term, and the remainder is the logarithm of the fourth term, or number sought. When an angle is greater than 90°, the sine, tangent, and secant of the supplement, (*i.e.* of the number of degrees wanting of 180°) are to be used.

"Two sides, and an angle opposite to one of them, being given to find the other opposite angle, and the third side, fig. 23." The side B C 106, D B 65 miles, and the angle B C D 31° 49′ given to find the angle B D C obtuse, and the side C D.

To find D.

As the sine B D 65....................	1.81291
Is to the angle C 31° 49′............	9.72198
So is the side B C 106...............	2.02531
	11.74729
	1.81291
To sine angle D 120° 43′	9.93438

To find D C.

As sine angle C 31° 49′...............	9.72198
Is to the sine B D 65.................	1.81291
So is sine angle B 27.28............	9.66392
	11.47683
	9.72198
To the sine D C 56.88...............	1.75485

Axiom III. In every plane triangle it will be as the sum of any two sides is to their difference; so is the tangent of half the sum of the angles opposite there, to the tangent of half their difference. Which half difference, being added to half the sum of the angles, gives the greater; but if subtracted, the remainder will be the lesser angle.

"Two sides, and their contained angle given, to find either of the other angles, and the third side, fig. 24." The side B C 109, B D 76 leagues, and the angle C B D 101° 30′ being given, to find the angle B D C, or B C D, and the side C D.

The side B C	109	....	109	....	180° 0′
B D	76	....	76	....	101° 30′
Sum	185	Diff...	33	....	78° 30′ sum of the two angle at D and C.
				Half....	39° 15′

To find the angles D *and* C.

As the sum of the sides B C and B D = 185	2.26717
Is to the difference 33	1.51851
So is the tangent of half the sum of angles C and D 39° 15′	9.91224
	11.43075
	2.26717
To the tangent of half the difference of the angles C and D 8° 17′	9.16358

To half the sum of the angles D and C..	39° 15′
Add half the difference of the angles C and D...	8° 17′
Gives the greater angle D..	47° 32′
But if subtracted (from 39° 15′) gives the lesser angle	30° 58′

Having the two angles, the side is found according to Axiom II: for it will be,

To find D C.

As the sine angle D 47° 32′..	9.86786
Is to the sine B C 109....................	2.03743
So is sine angle B 101 30′..	9.99116
	12.02862
	9.86786
To the side D C required 144.8	2.16076

Axiom IV. In any plane triangle, as the base, or greater side, is to the sum of the other two sides; so is the difference of the sides to the difference of the segments of the base, made by a perpendicular let fall from the angle opposite to the base: and if half the difference of the segments be added to half their sum, it will give the greater segment; but if subtracted, the remainder will be the lesser segment. The triangle being thus cut, becomes two right angled triangles; the hypothenuses and bases of which are given to find the angles by Axiom I.

Three sides given to find the angles.

The side BC 105, B D 85, and C D 50 miles, being given to find the angles B D C, B C D, and C B D, fig. 5.

	B D = 85
	C D = 50
The sum of the two shortest sides..	135
The difference of them..	35

The proportions will be

As the side B C..........................	105 —	2.02119 —	52½ the half of great side,
Is to the sum of the sides BD and DC	135 —	2.13033 —	22½ half diff. of segment.
So is the diff. of the sides BD and DC	35 —	1.54417	75 the greatest segment,
		3.67440	
		2.02119	30 the lesser segment.
Difference of the segment of the base, or great side..............................		451.65321	

Having divided the right-angled triangle into two right-angled triangles, the hypothenuses and bases of which are given, to find the angles by Gunter. 1. The extent from 105 to 135 will reach from 35 to 45 on the line of sines. 2. The extent from 85 to 75, on the line of numbers, will reach from radius to 61° 56′, the angle B D A on the line of sines. 3. The extent from 50 to 30, on the line of numbers, will reach from radius to angle A D C 36° 53′, on the line of sines.

TRIGONOMETRY, *spherical*, relates to triangles, or figures which are reducible to triangles, whose sides are segments of circles. Thus, if we describe a triangle on any spherical body, say a globe, it is evident that all the sides must be composed of curved lines; and it is the same in the case of a series of circles, or of orbits, intersecting each other. When two equal circles intersect, they will give a parabolic spindle; more or less acute, according as the centres of the two circles may be more or less distant. When three circles mutually intersect, there will be formed a great variety of spherical triangles, of which the areas, and the properties, could not be ascertained by plane-trigonometry; but come under consideration as parts of spherical surfaces. The following definitions should be clearly understood; they are simple in the extreme, but highly important: 1st. The poles of a sphere are two points in the superficies of the sphere, that are the extreme of the axis. 2d. The pole of a circle in a sphere is a point in the superficies of the sphere, from which all right lines that are drawn to the circumference of the circle are equal to one another. 3d. A great circle in a sphere, is that whose plane passes through the centre of the sphere; and whose centre is the same as that of the sphere. 4th. A spherical triangle is a figure comprehended under the arcs of three great circles in a sphere. 5th. A spherical angle is that which, in the superficies of the sphere, is contained under two arcs of great circles; and this angle is equal to the inclinations of the planes of the said circles. It is particularly to be held in mind, that although we can, upon any actual sphere, describe triangles at pleasure, which may nearly embrace the whole circumference, yet that such cannot be laid down, so as to be represented on paper; for every side of a spherical triangle is less than a semi-circle.

With respect to spherical triangles, the learner may generally entertain a correct opinion of their value, if he considers that every arc or segment of a circle may have a chord drawn from one to the other extremity; and that the triangle which can be contained within such arc or segment, taking the chord for a hypothenuse, will determine how much of that circle has been cut off, and is included between the extremes of the segment. It is utterly impossible to produce any two measurable segments taken from two different circles, which, having chords of equal length, will contain the same angle. A semicircle, having the diameter for its chord, will give a right angle; for if to any point within that semicircle two lines be drawn, from the ends of the chord respectively, their union at such assumed point will form a right angle. In proportion as the chord is less than a diameter, so must the segment be a less part of the whole circle, and the angle contained therein will be more acute. Spherical triangles may be acute, right-angled, or obtuse, the same as on plane-trigonometry. In all right-angled spherical triangles, the sign of the hypothenuse : radius :: sine of a leg : sine of its opposite angle. And the sine of the leg : radius :: tangent of the other leg : tangent of its opposite angle. In any right-angled spherical triangle, A B C (fig. 25), it will be as radius is to the co sine of one leg, so is the co-sine of the other leg to the co-sine of the hypothenuse. Hence, if two right-angled spherical triangles A B C, C B D (fig. 26), have the same perpendicular B C, the co-sines of their hypothenuses will be to each other directly as the co-sines of their bases. In any spherical triangle it will be, as radius is to the sine of either angle, so is the co-sine of the adjacent leg to the co-sine of the opposite angle. Hence, in right-angled spherical triangles, having the same perpendicular, the co-sines of the angles at the base will be to each other, directly, as the sines of the vertical angles. In any right-angled spherical triangle it will be, as radius is to the co-sine of the hypothenuse, so is the tangent of either angle to the co-tangent of the other angle. As the sum of the sines of two unequal arches is to their difference, so is the tangent of half the sum of those arches to the tangent of half their difference: and as the sum of their co-sines is to their difference, so is the co-tangent of half the sum of the arches to the tangent of half the difference of the same arches. In any spherical triangle A B C (fig. 27), it will be, as the co-tangent of half the sum of the angles, at the

base, is to the tangent of half their difference, so is the tangent of half the vertical angle to the tangent of the angle which the perpendicular C D makes with the line C F, bisecting the vertical angle.

The following propositions and remarks concerning spherical triangles, will render their calculation perspicuous and free from ambiguity. 1st. A spherical triangle is equilateral, isocelar, or scalene, according as it has its three angles all equal, or two of them equal, or all three unequal. 2d. The greatest side is always opposite the greatest angle, and the smallest side opposite the smallest angle. 3d. Any two sides, taken together, are greater than the third. 4th. If the three angles are all acute, or all right, or all obtuse, the three sides will be, accordingly, all less than 90°, or 90°, or greater than 90°. 5th. If from the three angles A, B, C, of a triangle A B C (fig. 28), as poles, there be described on the surface of the sphere, three arches of a great circle DE, DF, FE, forming by their intersections a new spherical triangle DEF; each side of the new triangle will be the supplement of the angle at its pole; and each angle of the same triangle will be the supplement of the side opposite to it in the triangle A B C. 6th. In any triangle A B C (fig. 29), or A *b* C, right-angled in A: 1st, The angles at the hypothenuse are always of the same kind as their opposite sides. 2dly. The hypothenuse is greater or lesser than a quadrant, according as the sides, including the right angle, are of the same, or different kinds; that is to say, according as the same sides, are either both acute, or both obtuse; or, as one is acute, and the other obtuse. And *vice versa*: 1st. The sides, including the right angles, are always of the same kind as their opposite angles. 2dly. The sides, including the right angles, will be of the same, or different kinds, according as the hypothenuse is less, or more, than 90°; but one, at least, of them will be of 90°, if the hypothenuse is so.

Considering it impossible to give a popular idea of this highly-important branch of mathematics, in any brief form, we must refer those readers, who wish to become proficients therein, to the various excellent treatises published on that subject; particularly those by Simpson, Bonycastle, Payne, &c.

TRIGUERA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Luridæ. Solaneæ, Jussieu. Essential character: corolla bell-shaped, with an unequal border; nectary short, five-toothed, surrounding the germ; filaments inserted into the nectary; berry four-celled, with two seeds in each cell. There are two species; *viz.* T. ambrosiaca, and T. inodora: these are both annual plants, and natives of Andalusia, in Spain.

TRILIX, in botany, a genus of the Polyandria Monogynia class and order. Essential character: calyx three leaved; corolla three petalled; berry five-celled, many-seeded. There is only one species; *viz.* T. lutea, a native of Carthagena, in America.

TRILLION, in arithmetic, a billion of billions. See ARITHMETIC, NUMERATION.

TRILLIUM, in botany, a genus of the Hexandria Trigynia class and order. Natural order of Sarmentaceæ. Asparagi, Jussieu. Essential character: calyx three-leaved; corolla three-petalled; berry three-celled. There are three species.

TRIM *of a ship*, her best posture, proportion of ballast, and hanging of her masts, &c. for sailing. To find the trim of a ship, is to find the best way of making her sail swiftly, or how she will sail best. This is done by easing of her masts and shrouds; some ships sailing much better when they are slack, than when they are taught, or fast; but this depends much upon experience and judgment, and the several trials and observations which the commander and other officers may make aboard.

TRIMMERS, in architecture, pieces of timber framed at right angles to the joints, against the ways for chimneys, and well-holes for stairs.

TRINGA, the *sand-piper*, in natural history, a genus of birds of the order Grallæ. Generic character: bill round, straight, slender, and about the length of the head; nostrils small and linear; tongue slender; toes very slightly, if at all, connected at the base by a membrane; hind-toe weak. There are thirty seven species, of which the following are the principal.

T. pugnax, or the ruff, is twelve inches long. The male is distinguished by a ruff, differing in colour on almost every bird, composed of long feathers, standing out in a peculiar manner, and constituting an appearance somewhat resembling the fashionable neck-ruff of the age of Queen Elizabeth. These feathers are not acquired till the second year, and continue only during the season of spring; after which, also, the caruncles which previously rise on the face of the male shrink back and disappear. The males of these birds are thought far more

numerous than the females. Frequent conflicts between the former are occasioned from this circumstance, and in the commencement of spring a male sand-piper is said to take his station near some water, and run round a particular spot such a number of times, that at length he bares a circular path upon the herbage. On the appearance of a female near this spot, the males engage in the most animated and ferocious contests, and, occupied solely by the idea of triumphing over their rivals, they suffer themselves to be taken by the net of the fowler, who avails himself of these opportunities for their destruction. In England they are migratory, and are found frequently in Lincolnshire and the Isle of Ely, where, after being taken, they are fed for sale, till they at length become nearly a mass of marrowy substance, and are sent to the markets of the metropolis.

T. vanellus, or the lapwing, is thirteen inches long, and of the weight of eight ounces. It remains in England the whole year; lays its eggs on the ground; and the female bird exercises various arts to attract the attention of mischievous and depredating schoolboys from the discovery of her nest, and is said, with this view, even to pretend lameness to direct their pursuit to herself. In winter these birds appear in flocks of several hundreds, and are caught in great numbers, being highly esteemed for food. They live chiefly upon worms, which appear to constitute their delicious banquet, and are sometimes familiarized, and kept in gardens to clear them of slugs and worms, in search for which, both in the morning and evening, they are extremely assiduous.

T. hypoleucos, or the common sand-piper, breeds in this country, but soon withdraws after the summer. It is about eight inches long, and is distinguished by its piping note. It is found in France, Siberia, and America.

The T. canutus is about ten inches in length, and weighs four ounces, and frequents the coasts of Lincolnshire, where it is taken in considerable numbers, and fattened for the London market. By some these birds are preferred to the ruff.

TRINITY *house*, a kind of college belonging to a company or corporation of seamen, who, by the King's charter, have power to take cognizance of those persons who destroy sea-marks, and to get reparation of such damages; and to take care of other things belonging to navigation. At present, many in the first rank of society are members of that community. The master, wardens, and assistants of the Trinity House, may set up beacons, and marks for the sea, in such places, near the coasts or forelands, as to them shall seem meet. By a statute of Queen Elizabeth, no steeple, trees, or other things standing as sea-marks, shall be taken away or cut down, upon pain that every person guilty of such offence, shall forfeit 100*l.* and if the person offending be not possessed of the value, he shall be deemed convict of outlawry.

TRINOMIAL, or TRINOMIAL *root*, in mathematics, is a root consisting of three parts, connected together by the signs $+$ or $-$, as $x+y+z$, or $a+b-c$. See BINOMIAL and ROOT.

TRIO, in music, a part of a concert wherein three persons sing; or more properly a musical composition consisting of three parts. Trios are the finest kinds of composition, and these are what please most in concerts.

TRIOPTERIS, in botany, a genus of the Decandria Trigynia class and order. Natural order of Trihilatæ. Malpighiæ, Jussieu. Essential character: calyx five-parted, with two honey pores at the base on the outside; petals roundish, clawed; filaments cohering at the base; capsules three, one-seeded, three or four-winged. There are eight species.

TRIOSTEUM, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Aggregatæ. Caprifolia, Jussieu. Essential character: calyx length of the corolla; corolla one-petalled, almost equal; berry three-celled, inferior; seeds solitary. There are three species.

TRIPARTITE, something divided into three parts, or made by three parties, as indenture tripartite.

TRIPLE *time*, in music, a time consisting of three measures in a bar; the two first of which are beat with the hand or foot down, and the third marked by its elevation.

TRIPLARIS, in botany, a genus of the Triandria Trigynia class and order. Natural order of Polygoneæ, Jussieu. Essential character: calyx very large, three, or six-parted; corolla three-petalled, or none; nut three-sided, within the ovate base of the calyx. There are two species; viz. T. Americana, and T. ramiflora.

TRIPLICATE *ratio*, the ratio which cubes bear to one another. This ratio is to be distinguished from triple ratio, and may be thus conceived: in the geometrical

proportions 2, 4, 8, 16, 32, as the ratio of the first term (2) is to the third (8) duplicate of that of the first to the second, or of the second to the third, so the ratio of the first to the fourth is said to be triplicate of the ratio of the first to the second, or of that of the second to the third, or of that of the third to the fourth, as being compounded of three equal ratios. See RATIO.

TRIPOLI, in mineralogy, a species of the Clay genus, is of a greyish colour: it occurs massive, is soft and friable, feels meagre, and does not adhere to the tongue. It occurs in veins and beds in floëtz rocks, and perhaps in alluvial land. It is found in beds in the coal works of Thuringia: in Derbyshire it occurs in veins: in Tripoli, whence its name is derived, it also forms veins. It is also found in Russia, Westphalia, Flanders, Hessia, Bohemia, and Switzerland. When reduced to powder, it is employed for polishing metals, marbles, and other minerals, and likewise for polishing glass. Formerly it was supposed to be a volcanic production, which has been long since disproved, and it appears to be an extremely fine mixture of clay and sand.

TRIPPANE, in mineralogy, is of an apple-green, or greenish white. It occurs in mass, is moderately hard, and easily frangible. Specific gravity is 3.21. Before the blow-pipe, it becomes yellow, and splits into thin plates, and then melts into a thin transparent glass. It has hitherto been found in Sweden, in veins of quartz and mica.

TRIPPING, in heraldry, denotes the quick motion of all sorts of deer, and of some other creatures, represented with one foot as it were on a trot.

TRIPSACUM, in botany, a genus of the Monoecia Triandria class and order. Natural order of Gramina, Gramineæ, or Grasses. Essential character: male, calyx glume four-flowered; corolla glume membranaceous: female, calyx glume with perforated sinuses; corolla glume two-valved; styles two; seed one. There are two species, viz. T. dactyloides, and T. hermaphroditum.

TRISECTION, or TRISSECTION, the dividing a thing into three. The term is chiefly used in geometry, for the division of an angle into three equal parts. The trisection of an angle geometrically, is one of those great problems whose solution has been so much sought by mathematicians for these two thousand years, being, in this respect, on a footing with the quadrature of the circle, and the duplicature of the cube angle.

TRISPAST, in mechanics, a machine with three pullies, or an assemblage of three pullies for raising of great weights.

TRITICUM, in botany, *wheat*, a genus of the Triandria Digynia class and order. Natural order of Gramina, Gramineæ, or Grasses. Essential character: calyx two-valved, solitary, subtriflorous; corolla blunt with a point. There are nineteen species. T. æstivum, or spring-wheat, has four flowers in a calyx, three of which mostly bear grain. The calyces stand pretty distant from each other, on both sides a flat smooth receptacle. The leaves of the calyx are keel-shaped, smooth, and they terminate with a short arista. The glumes of the flowers are smooth and bellying, and the outer leaf of three of the glumes in every calyx is terminated by a long arista, but the three inner ones are beardless. The grain is rather longer and thinner than the common wheat. It is supposed to be a native of some part of Tartary. The farmers call it spring-wheat, because it will come to the sickle with the common wheat, though it should be sown in February or March. T. hybernum, winter or common wheat, has also four flowers in a calyx, three of which are mostly productive. The calyces stand on each side a smooth flat receptacle, as in the former species, but they are not quite so far asunder. The leaves of the calyx are bellying, and so smooth that they appear as if polished, but they have no arista. The glumes of the flowers too are smooth, and the outer ones, near the top of the spike, are often tipped with short aristæ. The grain is rather plumper than the former, and is the sort most generally sown in England; whence the name of common wheat. T. turgidum, thick-spiked or cone-wheat, is easily distinguished from either of the former; for though it has four flowers in a calyx, after the manner of them, yet the whole calyx, and the edges of the glumes, are covered with soft hairs. The calyces, too, stand thicker on the receptacle, and make the spike appear more turgid. Some of the outer glumes, near the top of the spike, are terminated by short aristæ, like those of the common wheat. The grain is shorter, plumper, and more convex on the back than either of the former species. Its varieties are numerous, and have various appellations in different counties, owing to the great affinity of several of them

TRITOMA, in natural history, a genus of insects of the order Coleoptera. Antennæ clavate, the club perfoliate; lip emarginate; anterior feelers hatchet-shaped; shells as long as the body. There are ten species, found in different parts of the world. T. bipustalata, is black; shells with a lateral scarlet spot. It inhabits England, and is found on tree fungi. The glabra is found in Sweden, under the bark of trees.

TRITON, in natural history, a genus of the Vermes Mollusca class and order. Body oblong; mouth with an involute spiral proboscis; tentacula twelve, six on each side, divided nearly to the base, the hind ones cheliferous. T. littoreous, inhabits Italy, in cavities of sub-marine rocks, and may be seen in various species of Lepas, particularly the anatefera. It is fully described in the "Philosophical Transactions," vol. 50.

TRITURATION, in pharmacy, the act of reducing a solid body into a subtle powder; called also levigation, and pulverization.

TRIUMFETTA, in botany, a genus of the Dodecandria Monogynia class and order. Natural order of Columniferæ. Tiliaceæ, Jussieu. Essential character: calyx five-leaved; corolla five-petalled; capsule hispid, opening in four parts. There are eleven species.

TRIXIS, in botany, a genus of the Syngenesia Polygamia Necessaria class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: corollets of the ray trifid; seeds hairy at the tip, without any down; receptacle chaffy. There are three species, all natives of the West Indies.

TROCHAIC *verse*, in the Latin poetry, a kind of verse, so called, because the trochees chiefly prevail, as the iambus does in the iambic. It generally consists of seven feet and a syllable; the odd feet, for the most part, consist of trochees, though a trybraches is sometimes admitted, except in the seventh foot: these two feet are likewise used in the other places, as is also the spondæus, dactylus, and anapæstus. The following is an example.

1 2 3 4 5 6
Solus | *aut rex* | *aut po* | *eta* | *non quot* | *annis* |
7 ½
nasci | *tur.*

TROCHE, in pharmacy, a sort of medicine, made of glutinous substances, into little cakes, and afterwards exsiccated.

TROCHILUS, the *humming bird*, in natural history, a genus of birds of the order Picæ. Generic character: bill slender and weak; nostrils minute; tongue long, constituted of two united cylindric tubes, and missile; tail of ten feathers; legs weak. The bills of some are curved, and of others strait, which forms the grand division of the genus. There are sixty species enumerated by Latham, and Gmelin has sixty-five. The birds of this genus are the smallest of all birds. They subsist many of them on the juices of flowers, which they extract like bees, while on the wing, fluttering over their delicate repast, and making a considerable humming sound, from which they derive their designation. They are gregarious, and build their nests with great neatness and elegance, lining them with the softest materials they can possibly procure.

T. colubris, or the red throated humming-bird, is rather more than three inches long, and is frequent in various parts of North America. Its plumage is highly splendid and varying; it subsists on the nectar of flowers, particularly those of a long tube, like the convolvus or tulip. They will suffer themselves to be approached very nearly; but on observing an effort to seize them, dart off with the rapidity of an arrow. A flower is frequently the subject of bitter conflict between two of these birds; and they will often enter an open window, and after a short contest retire. They sometimes soar perpendicularly to a considerable height, with a violent scream. If a flower which they enter furnishes them with no supply, they pluck it, as it were in punishment and revenge, from its stalk. They have been kept alive in cages for several weeks, but soon perish for want of their usual food, for which no adequate substitute has yet been found. Latham, however, mentions the curious circumstance of their being preserved alive by Captain Davies for four months, by the expedient of imitating tubular flowers with paper, appropriately painted, and filling the bottom of the tubes with sugar and water as often as they were emptied. They then took their nourishment in the same manner as when unconfined, and soon appeared familiarised and happy. They lived, however, only four months. These birds generally build on the middle of the branch of a tree, and lay two eggs in an extremely small and admirably constructed nest.

T. minimus. This is the smallest of all the species, and is said, when just killed, to

weigh no more than twenty grains. Its total length is an inch and a quarter. It is found in the West Indies and South America, and is exceeded both in weight and magnitude by several species of bees.

For the amethystine humming-bird see Aves, Plate XIV. fig. 3.

TROCHLEA, one of the mechanical powers, usually called a pulley. See MECHANICS.

TROCHOID, in geometry, a curve more generally known by the name of cycloid. See CYCLOID.

TROCHUS, in natural history, a genus of the Vermes Testacea. Animal a limax; shell univalve, spiral, more or less conic; aperture somewhat angular or rounded, the upper side transverse and contracted, pillar placed obliquely. There are about 150 species, divided into sections. A. Erect, with the pillar perforated. B. Imperforate, erect, the umbilicus, or navel, closed. C. Tapering, with an exserted pillar, and falling on the side when placed on the base. Of these we may notice T. telescopium: shell imperforate, striate, with a spiral pillar. It inhabits the Indian ocean, and is about four inches long; the shell is tapering, like a telescope when drawn out; brown liver colour, or blackish, the first whorl generally barred with white; pillar a little prominent, with a tooth or plait in the middle; whorls flattish.

TROGON, the *curucui*, in natural history, a genus of birds of the order Picæ. Generic character: bill short, thick, and convex, serrated at the edges; nostrils covered with stiff bristles; toes, two before and two behind; tail of twelve feathers. Birds of this genus chiefly inhabit South America, live solitary in moist places, and in pathless overgrown woods; make short flights, and subsist principally on insects. There are seven species.

T. curucui, the red-bellied curucui, is an inhabitant of Cayenne, and is about as large as a magpie. These birds are not gregarious, and are never seen but alone, or in pairs. They lay their eggs in the holes of trees upon the rotten dust, preparing no nest. The male is mute, unless in spring, and then has a plaintive and monotonous note. The young, when first hatched, are bare of feathers, and have a head very disproportionately large to the body; they are fed with insects and caterpillars till able to provide for themselves, and then left by their parents, who return to their sequestered haunts, and in September are engaged with a second brood. When confined, they refuse all food, and, consequently, soon perish.

TROLLIUS, in botany, *globe flower*, a genus of the Polyandria Polygynia class and order. Natural order of Multisiliquæ. Ranunculaceæ, Jussieu. Essential character: calyx none; petals about fourteen; capsules numerous, ovate, many-seeded. There are two species, viz. T. Europæus, European globe flower, and T. Asiaticus, Asiatic globe flower.

TRONAGE, the mayor and commonalty of the city of London, are ordained keepers of the beams and weights for weighing merchants' commodities, with power to assign clerks, porters, &c. of the great beam and balance; which weighing of goods and wares is called tronage.

TROPÆOLUM, in botany, *Indian cress*, a genus of the Octandria Monogynia class and order. Natural order of Trihilatæ. Gerania, Jussieu. Essential character: calyx one-leafed, with a spur; petals four, unequal; nuts three, coriaceous. There are five species.

TROPE, in rhetoric, a kind of figure of speech, whereby a word is removed from its first and natural signification, and applied with advantage to another thing, which it does not originally mean; but only stands for it, as it has a relation to, or connection with it: as in this sentence, *God is my rock*. Here the trope lies in the word *rock*, which being firm and immoveable, excites our minds the notion of God's unfailing power, and the steady support which good men receive from their dependence upon him.

TROPHIS in botany, a genus of the Dioecia Tetrandria class and order. Natural order of Calycifloræ. Essential character: male, calyx none; corolla four-petalled; female, calyx none; corolla none; style two-parted; berry one seeded. There is but one species, viz. T. Americana, the ramoon tree, which is a native of Jamaica and other islands in the West Indies in exposed situations.

TROPHY, among the ancients, a pile or heap of arms of a vanquished enemy, raised by the conqueror in the most eminent part of the field of battle. The trophies were usually dedicated to some of the gods, especially Jupiter. The name of the deity to whom they were inscribed, was generally mentioned, as was that also of the conqueror. The spoils were at first hung upon the trunk of a tree; but instead of trees, succeeding ages erected pillars of stone, or brass, to continue the memory

themselves. To demolish a trophy was looked upon as a kind of sacrilege, because they were all consecrated to some deity.

TROPICS, in astronomy and geography, are two circles supposed to be drawn on each side of the equinoctial, and parallel to it. That on the north side of the line is called the tropic of cancer, and the southern tropic has the name of capricorn, as passing through the beginning of those signs. They are distant from the equinoctial 23° 28'. Two circles drawn at the same distance from the equator on the terrestrial globe, have the same names in geography, and they include that space or part of the sphere, which is called the torrid zone because the sun is, at one time or other, perpendicular over every part of the zone, and extremely torrifies or heats it.

TROVER is the remedy prescribed by the law, where any person is in possession of the property of another, which he unlawfully detains. Previously to commencing the action, a demand of the property so detained, must be made in writing, by some person properly authorised by the owner of the property; and upon refusal to restore it, the law presumes an unlawful conversion and the party is entitled to this action, and will recover damages to the value of the property detained. In trover, the smallest damages will carry costs. A similar action may be brought for the unlawful detention of any property, on which the specific articles, so detained, may be recovered, which is called detinue; but as the articles detained must be precisely stated in the declaration, and it is attended with some difficulty, this action is very seldom brought.

TROY *weight*, in commerce. See WEIGHT.

Troy weight, formerly called Trone weight, is supposed to be taken from a weight of the same name in France, which was taken from the name of the town of Troyes. The original of all weights used in England, was a grain of wheat, taken out of the middle of the ear, and, when well dried, thirty-two of them were to make one penny-weight: twenty penny-weights, one ounce: and twelve ounces one pound. Afterwards it was thought sufficient to divide the penny-weight into twenty-four equal parts, called grains, which is the least weight now in common use.

TRUCE, in the art of war, denotes a suspension of arms, or a cessation of hostilities between two armies, in order to settle articles of peace, bury the dead, or the like.

TRUCKS, among gunners, round pieces of wood in form of wheels, fixed on the axle-trees of carriages, to move the ordnance at sea, and sometimes also at land.

TRUFFLES, in natural history, a kind of subterraneous vegetable production, not unlike mushrooms, being a genus of fungi, which grows under the surface of the earth.

TRUMPET, in music. See MUSICAL instruments.

TRUMPET, *speaking*, is a tube of considerable length, viz. from 5 feet to 12, and even more, used for speaking with to make the voice heard to a greater distance. In a trumpet of this kind the sound in one direction is supposed to be increased, not so much by its being prevented from spreading all round, as by the reflection from the sides of the trumpet. The figure best suited for the speaking trumpet is that which is generated by the rotation of a parabola, about a line parallel to the axis. The trumpet used at sea is represented by fig. 10, Plate XVI. Miscel. It is an hollow instrument of copper, or of tinned iron plates. It is open at both ends, and the narrow end A is shaped so as to go round the speaker's mouth, and to leave the lips at liberty within it. The edge of this narrow end A is generally covered with leather or cloth, in order that it may more effectually prevent the passage of any air between the trumpet and the face of the speaker. The words which are spoken through a speaking trumpet may be heard much further and louder, but not so distinctly, as without the trumpet. A speaking trumpet has been applied to the mouth of a gun or pistol, by which means the explosion has been rendered audible at a vast distance. Such contrivances it has been thought might be used as signals in certain cases.

TRUMPET, *hearing*, is an instrument to assist the hearing of persons who are deaf. Instruments of this kind are formed of tubes, with a wide mouth, and terminating in a small canal, which is applied to the ear. The form of these instruments evidently shows how they conduce to assist the hearing, for the greater quantity of the weak and languid pulses of the air being received and collected by the large end of the tube, are reflected to the small end, where they are collected and condensed; thence entering the ear in this condensed state, they strike the tympanum with a greater force than they could naturally have

done from the ear alone. Hence it appears, that a speaking trumpet may be applied to the purpose of a hearing trumpet, by turning the wide end towards the sound, and the narrow end to the ear.

TRUNCATED, in general, is an appellation given to such things as have, or seem to have, their points cut off: thus we say, a truncated cone, pyramid, leaf, &c.

TRUNCHEON, a short staff, or battoon, used by kings, generals, and great officers, as a mark of their command.

TRUNDLE, a sort of carriage with low wheels, whereon heavy and cumbersome burdens are drawn.

TRUNNIONS, or TRUNIONS *of a piece of ordnance*, are those knobs or bunches of the gun's metal, which bear her up on the cheeks of the carriage: and hence the trunnion-ring is the ring about a cannon, next before the trunnions.

TRUSS, a bundle, or certain quantity of hay, straw, &c. A truss of hay is to contain fifty-six pounds, or half an hundred weight; thirty-six trusses make a load. In June and August the truss is to weigh sixty pounds, on forfeiture of eighteen shillings per truss.

TRUSS, in naval affairs, a machine employed to pull a lower yard close to its mast, and retain it firmly in that position: it is rarely employed except in flying top gallant sails. It is a ring or traveller which encircles the mast, and has a rope fastened to its after part, leading downward to the top or decks; by means of which the truss may be straitened or slackened at pleasure.

TRUSS is also used for a sort of bandage or ligature, made of steel, or the like matter, wherewith to keep up the parts, in those who have hernias or ruptures.

TRUST, is a right to receive profits of land, and to dispose of the land in equity; and one holding the possession and disposing thereof at his will and pleasure, are signs of trust. A trust is but a new name given to an use, and invented to evade the statute of uses. By statute 29 Charles II. c. 3, all declaration or creation of trusts shall be manifested by some writing signed by the party, or by his last will in writing, or else shall be void. And by section 9 of the same act, assignments of trusts shall be in writing, signed by the party assigning the same, or by his last will, or else shall be of no effect.

By 29 Charles II. all declarations of trusts were to be made in writing: but in the said act there is a saving with regard to trusts resulting by implication of law, which are left on the footing whereon they stood before the act; now, a bare declaration by parol before the act would prevent any resulting trust.

If a man purchase lands in another's name, and pay the money, it will be a trust for him that paid the money, though there be no deed made declaring the trust thereof; for the statute of frauds and perjuries extends not to trusts raised by operations of law.

TUB, *match*, in naval affairs; the half of a cask, having notches sawn in its edges, in which the lighted matches are placed during action, the bottom being covered with water to extinguish any sparks which may fall from the match.

TUBE, in general, pipe, conduit, or canal; a cylinder hollow withinside, either of lead, iron, wood, glass, or other matter, for the air, or some other fluid, to have a free passage, or conveyance, through. Small silver or leaden tubes are frequently used, by surgeons, to draw off blood, matter, or water, from the different parts of the body: they are made of various sizes and shapes.

TUBE, in astronomy, is sometimes used for a telescope, or more properly, for that part thereof into which the lenses are fitted, and by which they are directed and used.

We have now certain articles in domestic use, as toasting-forks, &c. made on the principle of telescope tubes.

TUBULARIA, in natural history, a genus of the Vermes Zoophyta class and order. Stem tubular, simple or branched, fixed by the base; animal proceeding from the end of the tube, and having its head crested with tentacula. Twenty-six species have been enumerated. T. magnifica: tube simple, whitish; tentacula very numerous, variegated with red and white. It is found in the West Indies, adhering to rocks; and is by far the largest and most splendid of its genus: like the rest of its tribe, it has the power of withdrawing its tentacula within the tube, and the tube within the rock on which it resides. It connects, as it were, the genera tubularia and amphitrite, having the annulated wrinkled tube of the one, and the retractile tentaculated body of the other. T. fistulosa inhabits the European, Mediterranean, and Atlantic Seas; about three inches long, and as thick as common packthread.

TUCK *of a ship*, the trussing or gathering up the quarter under water; which if she lie deep, makes her have a broad, or,

as they call it, fat quarter, and hinders her steering, by keeping the water from passing swiftly to her rudder; and if this trussing lie too high above the water, she will want bearing for her works behind, unless her quarter be very well laid out.

TUFA, in mineralogy, is calcareous, and of a yellowish-grey colour. It occurs solid, but generally porous, and marked with impressions of reeds, moss, and other vegetables: it is soft, easily frangible, and not much heavier than water: it effervesces with acids, and is little else than carbonate of lime. The more compact kinds are employed in building.

TULBAGIA, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Spathaceæ. Narcissi, Jussieu. Essential character: corolla funnelform, with a six-cleft border; nectary crowning the aperture, three-leaved; leaflets bifid, the size of the border; capsule superior. There are two species; *viz.* T. alliacea, narcissus-leaved tulbagia; and T. cepacea: both natives of the Cape of Good Hope.

TULIPA, in botany, *tulip*, a genus of the Hexandria Monogynia class and order. Natural order of Coronariæ. Lilia, Jussieu. Essential character: corolla six-petalled, bell-shaped; style none. There are five species.

TUN, or TON, originally signifies a large vessel or cask of an oblong form, biggest in the middle, and diminishing towards its two ends, girt about with hoops, and used for stowing several kinds of merchandize, for convenience of carriage; as brandy, oil, sugar, skins, hats, &c. This word is also used for certain vessels of extraordinary bigness, serving to keep wine in for several years.

TUN is also a certain measure for liquids; as wine, oil, &c. See MEASURE.

TUN is also a certain weight whereby the burden of ships, &c. are estimated.

TUNE, or TONE, *in music*, is that property of sounds by which they come under the relation of acute and grave. If two or more sounds be compared together in this relation, they are either equal or unequal in the degree of tune; such as are equal, are called unisons; the unequal constitute what are called intervals, which are the differences of tone between sounds. Sonorous bodies are found to differ in tone: 1st. According to the different kinds of matter: thus the sound of a piece of gold, is much graver than that of a piece of silver of the same shape and dimensions. 2d. According to the different quantities of the same matter in bodies of the same figure; as a solid sphere of brass, of one foot diameter, sounds acuter than a sphere of brass of two feet diameter. But the measures of tone are only to be sought in the relations of the motions that are the cause of sound, which are most discernible in the vibration of chords. Now, in general, we find that in two chords, all things being equal excepting the tension, the thickness, or the length, the tones are different; which difference can only be in the velocity of their vibratory motions, by which they perform a different number of vibrations in the same time; as it is known that all the small vibrations of the same chord are performed in equal times. Now the frequenter or quicker those vibrations are, the more acute is the tone; and the slower and fewer they are in the same space of time, by so much the more grave is the tone. So that any given note of a tune is made by one certain measure of velocity of vibrations, that is, such a certain number of vibrations of a chord or string, in such a certain space of time, constitutes a determinate tone.

TUNGSTATE. See TUNGSTIC *acid*.

TUNGSTEN, in mineralogy, is usually of a yellowish and greyish white: it occurs massive, disseminated, and very frequently crystallized: it sometimes occurs in large, coarse, and small granular distinct concretions, with streaked and shining surfaces. Its specific gravity is from 4.3 to 6. It is infusible, without addition, before the blowpipe. It melts with borax, but scarcely changes its colour. When pulverized and digested with nitrous or muriatic acid, it leaves a yellow residue which is the oxide of tungsten. The mineral contains, according to Scheele,

Yellow oxide of tungsten	65
Lime	31
Silica	4
	100

This specimen was obtained in Sweden: a specimen from Cornwall analyzed by Klaproth yielded

Yellow oxide of tungsten	75.25
Lime	18.70
Oxide of iron	1.25
——— manganese	0.75
Silica	1.50
	97.45
Loss	2.55
	100

It occurs in primitive mountains, and belongs to the oldest metalliferous formations. It is usually accompanied with tinstone, wolfram, quartz, mica, steatite, fluor-spar, &c. The Cornish tungsten is accompanied with iron-stone and hematite. It is found in Cornwall, Sweden, Saxony, and Germany. It is distinguished from tinstone by its octahedral crystals, the intensity of its lustre, its hardness, and its greater specific gravity. When Bergman analyzed this mineral he conjectured that the basis of the acid might be a metallic substance. This metallic substance has been only found in the state of acid in combination with lime, iron, manganese and lead. When it is combined with lime, it is the tungsten of the Swedes, and in combination with iron, it is called wolfram. To obtain this metal from the acid, it is mixed with charcoal in a crucible, and exposed to a very strong heat. By this process the metal was obtained in the form of a small button at the bottom of the crucible in the first experiments which were made upon it by the German chemists. This crumbled to pieces between the fingers, and when it was examined with a magnifying glass, it was found to consist of a number of metallic globules, none of which were larger than a pin head. The colour of this metal is a steel grey. The specific gravity is 17.6, or, according to others, 17.22. It is one of the hardest of the metals. It is also one of the most infusible, requiring a temperature of 170° Wedgwood.

It crystallizes on cooling. When it is heated in the open air, it is readily converted into a yellow oxide, which afterwards, by a stronger heat, becomes of a black colour, and then by combining with a greater proportion of oxygen, it assumes the character of an acid, namely the tungstic acid, whose properties and combinations with alkalies and earths, will be presently described.

Tungsten combines with phosphorous, forming a phosphuret, the properties of which are unknown. It also combines with sulphur, forming a sulphuret of a bluish black colour, and which may be crystallized. There is no action between this metal and sulphuric, nitric, or muriatic acids. It is only acted on by nitro-muriatic acid at a boiling temperature, and nitrous gas is disengaged. Nothing therefore is known of the combinations of tungsten with the other acids. This metal combines with the other metals, and forms alloys with them.

TUNGSTIC *acid*. In the year 1781, Scheele and Bergman, in investigating the nature of tungsten by the Swedes, discovered that it is composed of lime combined with a peculiar acid. Their discovery was afterwards confirmed by several chemists, who detected the same acid in the mineral called wolfram. This acid always exists in combination with lime and iron. It may be obtained by reducing the former to a fine powder, and treating it with nitric or muriatic acids, which unite with the lime, and then by alkalies, which dissolve the acid. The alkaline solution is to be precipitated by the nitric or muriatic acid; the precipitate is to be carefully washed and dried, which is the tungstic acid in the solid state. The tungstic acid thus prepared, is in the form of a white powder, which has an acid and metallic taste, changes the colour of vegetable blues into red, and has a specific gravity, according to Bergman, equal to 3.6. Heated before the blow-pipe, the tungstic acid becomes first yellow, then brown, and at last black, it affords no smoke, and gives no sign of fusion. When it is calcined for some time in a crucible, it is deprived of the property of dissolving in water. Exposed to the air it suffers no change. It is soluble in twenty parts of boiling water, but it is partially separated on cooling.

This solution has an acid taste, and reddens the tincture of turnsole. Heated with charcoal, it is reduced, but with difficulty, to the metallic state. With sulphur and phosphorus it becomes of a grey colour, but without reduction. The acids do not dissolve the tungstic acid in the form of white powder, but they change completely its properties. The sulphuric acid changes it to a blue, and the nitric and muriatic acids convert it into a fine yellow colour. In this state it has lost its taste and solubility, has become specifically heavier, and has acquired the property of forming salts with the same bases distinctly different from those formed with what was called the white acid. The compounds which it forms with the alkalies, earths, and metallic oxides, are a species of neutral salts, but the chemical combination is not fully completed to hidd the alkaline properties of the former. In forming these compounds, it is the only property in which it agrees with

the acids. The compounds are denominated tungstates.

TUNNAGE is used for a custom or impost, payable to the crown, for goods and merchandize imported or exported, and is to be paid after a certain rate for every tun thereof. This duty, as well as that of poundage, was first granted for life to King Charles II. and has been continued in the same manner to his royal successors, down to his present majesty King George III.

TUNNEL *net*, a net for taking partridges, which should not exceed fifteen feet in length, nor be less than eighteen inches in breadth, or opening, for the entrance.

TUPIPORA, in natural history, a genus of the Vermes Zoophyta; animal a nereis; coral consisting of erect, hollow, cylindrical, parallel, aggregate tubes. There are ten species, of which we notice T. musica, with fasciculate connected tubes, and transverse, distinct, membranaceous dissepiments. It inhabits the Indian and American Seas, fixed to rocks and other corals: it is of a bright scarlet colour, consisting of an assortment of upright parallel tubes, rising over each other by stages like cells of an honey-comb, divided by transverse partitions. The Indians use it in cases of strangnary, and wounds inflicted by venomous animals.

TURBITH *mineral.* If sulphuric acid and mercury, namely, three parts of acid and two of mercury, be exposed for a longer time to the action of heat, a greater proportion of sulphuric acid is decomposed, and the mercury combines with a greater proportion of oxygen. The salt thus obtained possesses different properties from the former. It crystallizes in small prisms, and when it is neutralized it is of a dirty white colour; but if it be obtained in the dry state, it is pure white, and in this state it is combined with an excess of acid. It is then deliquescent in the air; but in the neutral state it undergoes no change. When hot water is added to this salt, it is converted into a yellow powder, which has been long distinguished by the name of turpeth mineral.

TURBO, in natural history, *wreath*; a genus of the Vermes Testacea class and order: animal a limax; shell univalve, spiral, solid; aperture contracted, orbicular, entire. This is a very numerous genus, divided into sections. A. pillar margin of the aperture dilated imperforate. B. solid imperforate. C. solid perforated. D. cancellate. E. Tapering.

TURDUS, the *thrush*, in natural history, a genus of birds of the order Passeres. Generic character: bill straitish, upper mandible somewhat bending, and notched near the point; nostrils oval, and half-covered with a small membrane, or naked; mouth ciliated with a few bristles at the corners; tongue jagged. There are one hundred and twenty-two species enumerated by Latham, and one hundred and thirty-five by Gmelin, of which we shall notice the following.

T. viscivorus, or the missel thrush. This bird is well known throughout Europe, and some think confined to it. In England it is stationary, in some other countries migratory. It builds its nest of moss and leaves in low trees, or rather shrubs, and lays four eggs. It feeds on the berries of holly, hawthorn, and other trees, and on caterpillars and insects. It is valued for food, but far more for that melody, which ought ever to be its security from the gun of the sportsman, and which it frequently commences so early as the very beginning of the year, animating the dullness, and softening the rigour of the season by its delightful song.

T. musicus, or the throstle, is nine inches long, and weighs three ounces, being considerably less than the former. It breeds so early as the beginning of April, and sometimes again in each of the two following months. Its nest is made of earth, straw, and moss, and plastered inside with clay. It is never seen in companies in England, where it remains through the whole year: in France it is migratory. Its song commences early in the season, and continues for nine months; and its notes are so rich and various, that, in the language of Milton, they can "charm all sadness but despair."

T. pilaris, or the field-fare, is ten inches long, passes the winter in England, when the season is extremely rigorous, in immense flocks, but in small parties when the winter is mild. These birds are said to have been much esteemed for the table by the Romans. In Sweden they build in high trees. They subsist principally on various sorts of berries.

T. merula, or the black-bird, is ten inches long, and found generally throughout Europe. It is fond of solitude, and never, or very rarely, seen in flocks. In summer it haunts orchards and gardens. In winter it secludes far from human society in the recesses of the woods. It builds in the same

situation, and with the same materials, as the throstle, and may be easily reared, tamed, and taught to imitate a variety of tunes, and to articulate words and phrases. But its natural song is far superior to all its efforts of imitation, and when listened to from a moderate distance, for its sound is very strong, has a most cheering and transporting effect.

T. cinclus, or the water-ouzel, is rather less than the former, is solitary, and met with in various parts of this island, subsisting not only upon insects but fish, which it procures by diving, and walking or running after them at the bottom of the water. It is said to have been taken by a line and hook, having snatched at the bait intended for fish. It is able to sustain extreme cold, and does not quit its watery haunts till the streams are frozen. It builds in the banks of rivers.

The musician thrush is four inches long, and a native of Cayenne, where it subsists principally on ants. It never quits trees but to procure its sustenance. It is called in Cayenne the musician, by way of eminence. It is said to deliver first seven notes of the octave, and then to whistle various airs in different tones, sometimes resembling the flute, at others the human whistle; and when it displays its most skilful efforts, it is preferred by some even to the nightingale. Its habits are solitary.

TURKEY. See MELEAGRIS.

TURMERIC, a root, which is cultivated largely in the East Indies; consists of a large oval bulb, from which spring two or three tortuous processes, three or four inches long. It has a fragrant smell, and an aromatic taste. The yellow colour which it exhibits is easily extracted, both by water and alcohol, and is sometimes used as a dye, which is very fugitive; therefore when employed in dyeing, it is chiefly to give a finishing gloss to the more solid colours, which soon fades away. The yellow of turmeric is rendered paler by the acids, but is changed to a brick-red by the alkalies: hence its great sensibility to alkaline tests. To apply it to this purpose, either a spirituous tincture or a watery infusion may be used; or, still more simply, a fresh cut surface of the entire root may be wetted with distilled water, and by being rubbed on white paper a visible yellow mark will be made, on which a drop of the liquor to be examined may be dropped. If the quantity of alkali be very small, it requires a few minutes to produce the full change.

TURNERA, in botany, so named in memory of William Turner, M. D. a genus of the Pentandria Trigynia class and order. Natural order of Columniferæ. Portulaceæ, Jussieu. Essential character: calyx five-cleft, funnel-form, exterior, two-leaved; petals five, inserted into the calyx; stigmas multifid; capsule one-celled, three-valved. There are nine species.

TURNING, in mechanics, a very ingenious and useful art, by which a great variety of articles are manufactured, by cutting or fashioning them while they revolve upon an axis or line, which in most cases remains immoveable. Every solid substance in nature may be submitted to this process, and accordingly we have articles turned in the metals, in wood, in pottery, in stone, in ivory, &c. so numerous, and so universally in use, that it would be superfluous to enumerate or point them out. In the present article we shall describe the art in a general way, sufficient to show its principles, and may be of utility in practice.

The simplest process of turning is that of the potter, who, in the first stage of forming his ware, sticks a piece of humid clay upon a wheel, or flat table, while it revolves horizontally, and in this state of rotation of the clay, he fashions it with the greatest facility into vessels of every description. But in most operations of the art the revolving body is cut or shaved by applying a chissel, or other suitable tool, to its surface, while in motion; a condition that requires firmness in the axis of rotation, and also that the tool itself should be steadily supported. The instrument, or apparatus for these purposes, is called a LATHE. See the article. Among the great varieties of lathes, it is indispensably required, for circular turning, that the work should be supported by two steady centres, or by parts equivalent to two centres, at a distance from each other in the axis of rotation, and that the tool should be supported by a steady bar, or piece called the rest. The mechanism for causing the rotation has been described in the article just referred to.

A great number of turned articles either have, or will admit of a perforation through their axis. All wheel-work, and most of the articles turned in wood, are of this description. Clock and watchmakers accordingly use a very cheap, simple, and portable lathe, called a turn-bench, consisting of a straight bar of iron, about five inches long, with two cross bars or heads, about two inches long, one fixed at the end of the long bar, and the other capable of being shifted by means of a socket and

screw. In each of these heads is a centre-pin terminating in a point at one end, and in a central hole at the other, like the centre-pin, in the poppet-head of any other lathe; the use of which is to afford point-centres when the points are turned towards each other, or hole centres when the contrary is the case; and lastly, there is a small rest with its support, slidable and adjustable along the bar, as in another lathe. These instruments, which cost five or six shillings at the watch tool shops, will therefore support any piece of four or five inches long, and three inches diameter between the centres, and the method of producing the rotation is by passing the catgut string of a bow once or twice round the work, and drawing the bow backwards and forwards with one hand, while the other is employed in applying the tool. The turn-bench itself is held steady in a vice fixed to a bench or stand.

Such pieces as have a hole through the centre, are drawn tightly upon an arbor or mandrel, having a pulley or ferril fixed upon it, to carry the gut or bow-string, and the mandrel itself is turned between the centres upon its own pointed extremities. There are mandrels fitted up in different ways for holding the work firmly, and if flat, at right angles to the motion; but we cannot consistently with brevity enter upon a description of them, which will immediately be understood by inspection in a workshop.

The common lathe of the turners in wood, called the pole-lathe, is the same thing as the watchmakers turn-bench, but upon a large scale, and a little varied. Instead of the horizontal bar it has two long stout bars of wood, called sheers, forming what is called the bed of the lathe, and its two poppet-heads are upright blocks of wood, mortised in between the sheers, above which they rise and carry the centre screws, and between which they are moveable, and may be wedged firmly at any required distance from each other. The work itself is either put between the centres, or upon a wooden mandril, and it is made to revolve by a string or band, proceeding from a long springing pole at the ceiling or roof of the shop, round the work, and thence to a treadle or foot board, which acts by alternate pressure from the foot, while the workman applies the cutting tool with his hands.

In these, and all similar lathes, the rotation is made backwards and forwards; and there are some kinds of work in which such a motion is advantageous; but in general it is much preferable that the work should constantly revolve the same way, as shown in the lathe described under that article, usually known by the name of the foot-lathe. In the regular foot-lathe, work is very seldom turned between the opposite centres, though this method certainly affords great truth and precision. The mandrel is here an essential part of the apparatus, which is always used. It has been shown that it is supported by a centre on the left hand, called the back centre, and by a steel collar in the middle poppet-head; and that the right hand extremity, or nose of the mandrel, terminates in a screw, either convex or concave, the latter of which is preferred in the best lathes. The various description of pieces screwed upon the nose of the mandrel, for holding or carrying work, are called chucks, probably because the work is mostly fastened by being driven, jammed, or choked into them.

When work is to be turned between centres by the foot-lathe, a centre-chuck, or steel-piece, carrying a projecting point, is screwed on the nose of the mandrel; and as this piece is not harder than blue, and may not always screw home to exactly the same bearing, accurate workmen are in the habit of turning or shaving the point in its place, so that it shall be truly centered. The opposite centre is afforded by the moveable poppet-head, and ought to be truly in the axis; and the mandrel is made to carry the work round by an arm and pin, or by any other ready method of connection.

Work, which is not to be turned between centres, is usually fastened to, or fixed in, a block or wooden chuck screwed on the mandrel. As it would be almost impossible to screw a wooden chuck upon the convex nose of a mandrel, and take it off as occasion required during the process, without altering the position, it is found much best that the screw of the mandrel should be hollow, and a brass chuck screwed therein, having its projecting screw to receive the wooden chuck; because, by this means, the work may be taken off repeatedly, if needful, without ever separating the brass and the wood; and the brass and the steel will take the same position when screwed together again.

Metallic or other work may be fastened to a wooden chuck by cement, or by glue, or by turning a cell in the wood, and driving the work gently and carefully into it till fixed.

The stronger, the firmer, and the better the workmanship of a lathe, the easier it will be to perform work with expedition and truth, but a good workman will make true and excellent work with a very indifferent lathe, by taking care to cut so little at a time that the parts of the engine may never be shaken out of their contact. Metallic lathes, if ever so strong, have an elastic tremor, which makes it difficult to cut brass and bell metal as firmly and smoothly as in wooden lathes, but the structure of the former admits of greater precision and truth. In a well constructed lathe, the back centre, the centre of the collar, and the fore centre, or centre of the moveable poppet-head, ought to be in one line, parallel to the bed or sheers. To prove this by trial, set the moveable poppet-head as far to the right hand as possible, and screw a stick of wood into the nose of the mandrel: into the middle of the right hand end of the stick, or nearly so, drive a pin or other projecting point, and by gentle blows against the stick, cause the point to remain steady in the axis, while the mandrel is turned round. If the centre point of the moveable poppet be truly opposite to this revolving point, the three centres are in a line, and if the same continues to be the case when the face of the moveable poppet is reversed, it is a proof that the hole in the poppet is bored parallel to the bed, and if the same adjustment continues when the stick is shortened, it shows that the bed is strait and parallel to the axis of work. If the collar and back centre, and the chamfer and point of the mandrel, in a lathe, be truly formed, and set square, the rotation slowly made by hand, when the back centre is rather firmly set up, will be equally stiff in every part, and the wearing parts, when examined, will have the same aspect, slope, and grain, in every part of their surfaces.

The velocity of rotation may be extremely swift in wood, slower in brass and bell metal, still slower in cast iron, and slowest of all in forged iron or steel. The reason for these limits appears to be, that a certain time is requisite for the act of cutting to take place, and that the tool itself, if heated by rotation, will instantly become soft, and cease to cut. Steel and iron require to be kept wetted. For rough work in wood the guage is a good tool, and after that the chisel, with its edge a little convex rather than strait lined. The graver is commonly used for metal; and for strong rough work, the hook tool, which is of excellent advantage, even in small work, on account of its extreme steadiness. When steel is to be cut extremely clean, a sharp hard tool may be useful, but for the most part in metallic work, even of steel, (if annealed), the hook tool, or graver, need not be harder than purple, or even blue. But to cut steel work or chill cast iron cylinders at a high temper, the tool must be very hard, the angle of edge obtuse, (say seventy degrees), and the motion slow.

Hitherto we have spoken of plain turning, which is indeed the most useful and most universally practised. But many other nice and very curious operations are performed by this art. If the poppet-heads, supporting the mandrel, be made regularly to move from side to side, during the rotation, or the rest be made to approach to, and recede from, the work, any number of times in a turn, the cuts will not be circular but undulating, indented or waved in any curve that may be required. Work of this kind, which is chiefly done in watch cases, snuff boxes, and trinkets, is called rose-work. The motion is commonly regulated by certain round plates of brass fixed on the mandrel, called roses, which have their edges waved, and are called roses.

Another deviation from regular turning is effected by causing the chuck, which carries the work, to recede crosswise from the centre of the mandrel, back and forward during the rotation. The effect of this is, that the diameters of the work are not all equal to each other. It is practicable to produce a variety of curves in this way, but in our art the process is confined to turning ovals, and the chuck by which the work is made thus to slide back and forward, is called an oval chuck.

Numerous geometrical figures are produced by turning, by an apparatus upon the principle of the geometrical pen of Suardi, in engines which have been made for curiosity, and at great expense.

Medallions, and other similar pieces, are produced by regulating the action of the tool in its advance to, or recess from, the face of a piece exposed to its action.

If the mandrel of a lathe be made to advance and recede in the line of the axis, once in each turn the cut will not be in a plane at right angles to the axis of the work, and the line traced upon the work will be an ellipsis, produced by the oblique section of a cylinder. This kind of work is called swash-work, and may be seen in some

old balustrades, where its effect is far from being pleasing. The nature of the curve thus described, which we have called an ellipsis will manifestly vary according to the law of the alternate motion in the mandrel. When the mandrel moves uniformly forward, the cut will be the common helix or screw; and the motion is used to make screws, though not very frequently, because good turners can easily make them by a a notched cutting tool, called the screw.

The act of turning is so extensively applicable, that it would require a volume to describe its uses, and the methods of practising it. Every round thing which is made by human hands may be referred to this art, as one of its products. The largest columns, the most ponderous artillery, and the minutest pivots of watch-work, with all wheel-work, rotatory machines, vessels, &c. are worked in this method.

TURNSOLE. See Litmus.

TURPENTINE. See Resins.

Turpentine, of which there are various kinds, are all products of some of the species of the pinus. From this genus are obtained not only turpentine, but resin, pitch, tar, &c. which are employed so extensively in ship-building, and in the rigging also: likewise in varnishes.

There are three varieties of pine turpentine, commonly known under that name in Europe: namely, 1. The common turpentine, obtained chiefly from the pinus sylvestris (Scotch fir). 2. The Strasburgh turpentine, yielded by the pinus pieca (silver fir). And, 3. The Venice turpentine, procured from the pinus larix (larch). Of the three first mentioned turpentines, the Venice is the thinnest and most aromatic; the Strasburgh the next in these qualities, and the common is the firmest and coarsest. The two former are often adulterated by a mixture of the common turpentine and oil of turpentine, and it is to be observed, that the terms Venice and Strasburgh turpentine are not now appropriate, as they are procured from various countries.

Common turpentine is obtained largely in the pine forests in the south of France, in Switzerland, in the countries on the north of the Pyrenees, in Germany, and in many of the southern States of North America. The greater part of what is consumed in this country is imported from North America. The method of obtaining it is by making a series of incisions through the bark of the tree, from which the turpentine exudes, and falls down into holes, or other receptacles at the foot.

The process is described very accurately by Duhamel and others, as practised in the south of France. The fir is generally allowed to remain untouched till it is thirty or forty years old. When it is to be worked, which is early in the spring, a small hole is first made in the ground at the foot of the tree, the earth of which is well rammed, and serves as a receptacle for the juice. The coarse bark is then stripped off from the tree, a little above the hole, down to the smooth inner bark, after which a portion of the inner bark, together with a little of the wood, is cut out with a very sharp tool, so that there may be a wound in the tree about three inches square, and an inch deep. Immediately afterwards the turpentine begins to exude in very transparent drops, which escape chiefly from the wood immediately under the inner bark. The hotter the weather is the greater is the supply of resin, and to facilitate the supply the incisions are enlarged every three or four days, by cutting off thin slices, till at the end of the year it is about a foot and a half wide, and two or three inches deep. The whole time during which the turpentine flows is from the end of February to October. In the winter it entirely ceases, but in the ensuing spring a fresh incision is begun a little above the former, and managed in the same manner. This practice is continued annually for about twelve or fifteen years in some parts, and in others a shorter time, on the same side of the tree, till the later incisions are so high as to be out of reach without the assistance of steps; after which the contrary side of the tree is begun upon, and worked in a similar manner for as many years, during which time the first incisions are grown up, and are fit to be cut afresh. In this way, a healthy tree, in a favourable soil, may be made to yield from six to twelve, or more, pounds of turpentine annually, sometimes for a century; and even the timber is not soon injured by this constant drain. The flow of turpentine discontinues altogether about October, and the liquid resin collected during the year, from each tree, is put together for further purification. But a considerable quantity of the resin has concreted during that time around the incision, particularly as the heat declines; and in the winter, when it has hardened considerably, it is scraped off, and forms what is technically called barras, or in some provinces galipot, which differs from the more liquid turpentine in consistence, and probably contains a less proportion of essential oil.

The galipot is much used in making flambeaux when mixed with suet, but the greater part of it, as well as the liquid turpentine, is subjected to further processes.

The Strasburgh turpentine, the produce of the silver fir, is the most fragrant of all the pine turpentines, and only inferior to the true Chio, but it is not often seen in the shops. It is obtained by rude incision of the bark by the peasants in the vast pine forests on the western Alps. The first cut is made as high as the hatchet will reach, and these are renewed annually from above downwards to within a foot of the ground. But the finest kind of turpentine yielded by this tree, is that which exudes from soft turbercles, or swellings of the inner bark. The peasants carry with them a large cow's horn, with the point of which they pierce these tubercles, and collect the juice in its hollow.

The true Venice turpentine, or resin of the larch, is obtained from the Tyrol and Savoy, and also from Dauphiny, by boring holes about an inch in diameter, with a gentle descent, in the most knotty parts of the tree. To these are adapted long perforated pegs, which serve as gutters to convey the juice into troughs placed beneath. It is yielded during the whole of the summer, and is simply purified by straining through hair sieves. A full grown larch will sometimes yield seven or eight pounds of turpentine annually for forty or fifty years.

TURQUOISE. The colour of this substance is pale sky-blue, passing into indigo-blue, and pale apple-green. It occurs in mass, or disseminated. Its fracture is even. Its hardness is nearly equal to that of glass; it is difficultly frangible. Specific gravity 3.12. Before the blow-pipe its colour changes to greyish-white, and it becomes friable, but it does not melt. It is soluble in nitro-muriatic acid, and the European varieties are so in nitric acid; this menstruum, however, has no action on the Persian turquoises. It is composed, according to Buillon la Grange, of

Phosphate of lime	80
Carbonate of lime	8
Phosphate of iron, with a trace of manganese	2
Phosphate of magnesia	2
Alumina	1
Water	6
Loss	1
	100

Turquoise is generally considered as fossil-bone, or ivory penetrated by oxide of copper; it appears, however, from the above analysis, that the colouring matter is phosphate of iron. The oriental turquoises are found near Meched in Persia, also in Mount Caucasus, in Egypt and Arabia. The occidental ones are found in Languedoc in France, and in Hungary. Turquoise was formerly in some estimation for rings and other articles of personal ornament, but its value has greatly declined in modern times. The colour of turquoise changes gradually by exposure to the air, from blue to green: when it arrives at this state its commercial value is wholly extinct.

TURRITIS, in botany, *tower-mustard*, a genus of the Tetradynamia Siliquosa class and order. Natural order of Siliquosæ, Cruciformes, or Cruciferæ. Essential character: silique very long, angular; calyx converging, erect; corolla erect. There are eight species.

TURRÆA, in botany, a genus of the Decandria Monogynia class and order. Natural order of Trihilatæ. Meliæ, Jussieu. Essential character: calyx five-toothed; petals five; nectary toothed, cylindrical, bearing the anthers at the mouth between the teeth; capsule pentacoccous; seeds two. There are five species.

TUSCAN *order*, in architecture, the first, simplest, and most massive of the five orders.

TUSSILAGO, in botany, *colt's-foot*, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx scales equal, as long as the disk, somewhat membranaceous; down simple; receptacle naked. There are fourteen species.

TWILIGHT, that light, whether in the morning before sun-rise, or in the evening after sun-set, supposed to begin and end when the least stars that can be seen by the naked eye cease, or begin, to appear. By means of the atmosphere it happens, that though none of the sun's direct rays can come to us after it is set, yet we still enjoy its reflected light for some time, and night approaches by degrees; for after the sun is hidden from our eyes, the upper part of our atmosphere remains for some time exposed to its rays, and from thence the whole is illuminated by reflection. But as the sun grows lower and lower, that portion of the atmosphere which is above our horizon, becomes enlightened till the sun has got

eighteen degrees below it; after which it ceases to be illuminated thereby, till it has got within as many degrees of the eastern side of the horizon; at which time it begins to illuminate the atmosphere again, and in appearance to diffuse its light throughout the heavens, which continues to increase till the sun be up. Hence it is, that during that part of the year in which the sun is never eighteen degrees below our horizon, there is a continued twilight from sun-setting to sun-rising. Now that part of the year in the latitude of London is, while the sun is passing from about the fifth degree of Gemini to the twelfth of Cancer; that is, from the middle of May to the middle of July.

As the twilight depends on the quantity of matter in the atmosphere fit to reflect the sun's rays, and also on the height of it (for the higher the atmosphere is, the longer will it be before the upper parts of it will cease to be illuminated), the duration of it will be various. For instance, in winter, when the air is condensed with cold, and the atmosphere upon that account lower, the twilight will be shorter; and in summer, when the limits of the atmosphere are extended by the rarefaction and dilatation of the air of which it consists, the duration of the twilight will be greater. And for the like reason, the morning twilight, the air being at that time condensed and contracted by the cold of the preceding night, will be shorter than the evening one, when the air is more dilated and expanded.

The beginning and end of twilight has been variously stated, by different observers; but, in our latitude, it may be said to begin and end when the sun is about eighteen degrees below the horizon: hence, when refraction is allowed for, the atmosphere must be capable of reflecting sensible light at the height of about forty miles. The duration of twilight is greater or less, as the sun moves more or less obliquely with respect to the horizon: hence it is shortest near the time of the equinoxes, because the equinoxial intersects the horizon less obliquely than any lesser circle parallel to it. Dr. Long has calculated the duration of twilight, in different latitudes, and for the several different declinations of the sun: the result he laid before the public in the following table, where the letters *c d* signify that it is then continual day; *c n* continual night; and *w n*, that the twilight lasts the whole night:

TABLE.

Latitude	0	10	20	30	40	45	50	51½	55	60	65	70	75	80	85	90
	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
☉ Enters ♋	1 18	1 21	1 28	1 41	2 [illegible]	2 39	w n	w n	w n	w n	w n	c d	c d	c d	c d	c d
♊ ♌	1 16	1 19	1 25	1 36	1 56	2 14	3 2	w n	w n	w n	w n	c d	c d	c	c d	c d
♉ ♍	1 13	1 15	1 20	1 28	1 43	1 55	2 18	2 25	2 41	3 55	w n	w n	w n	c d	c d	c d
♈ ♎	1 12	1 13	1 17	1 24	1 33	1 44	1 55	2 9	2 10	2 33	3 8	4 18	w n	w n	w n	w n
♓ ♏	1 13	1 14	1 18	1 24	1 35	1 43	1 54	2 0	2 6	2 31	2 56	3 41	5 2	7 34	w n	w n
♒ ♐	1 16	1 17	1 21	1 28	1 40	1 49	2 1	2 8	2 18	2 43	3 26	11 38	11 14	10 30	8 3[illegible]	c n
♑	1 18	1 19	1 23	1 30	1 43	1 53	2 6	2 15	2 26	2 51	4 4	10 24	9 30	7 46	c n	c n

TYCHONIC *system*, or *hypothesis*, an order or arrangement of the heavenly bodies, of an intermediate nature between the Copernican and Ptolemaic, or participating alike of them both. This system had its name and original from Tycho Brahe, a nobleman of Denmark, who lived in the latter part of the last century. The philosopher, though he approved of the Copernican system, yet could not reconcile himself to the motion of the earth; and being, on the other hand, convinced the Ptolemaic scheme could not be true, he contrived one different from either. In this the earth has no motion allowed it, but the annual and diurnal phenomena are solved by the motion of the sun about the earth, as in the Ptolemaic scheme; and those of Mercury and Venus are solved by this contrivance, though not in the same manner, nor so simply and naturally as in the Copernican system. The Tychonic system then supposed the earth in the centre of the world, that is, of the firmament of stars, and also of the orbits of the sun and moon; but at the same time it made the sun the centre of the planetary motions, viz. of the orbits of Mercury, Venus, Mars, Jupiter, and Saturn. Thus the sun, with all its planets, was made to revolve about the earth once

a year, to solve the phenomena arising from the annual motion, and every twenty-four hours, to account for those of the diurnal motion.

TYGER. See FELIS.

TYLE, or TILE, in building, a sort of thin, fictitious, laminated brick, used on the roofs of houses, or more properly a kind of fat clayey earth, kneaded and moulded, of a just thickness, dried and burnt in a kiln like a brick, and used in the covering and paving of houses. See BRICK.

There are various kinds of tyles, for the various occasions of building; as plain, thack, ridge, roof, crease, gutter, pan, crooked, Flemish, corner, hip, dormar, scallop, astragal, traverse, paving, and Dutch tyles.

Flemish or Dutch tyles are of two kinds: ancient and modern. The ancient were used for chimney foot-paces; they were painted with antique figures, and frequently with postures of soldiers, some with compartments, and sometimes with moresque devices, but they come much short of the design and colours of the modern ones. The modern Flemish tyles are commonly used plastered up in the jaumbs of chimnies, instead of chimney-corner stones. These are better glazed, and such as are painted (for some are only white) are done with more curious figures, and more lively colours, than the ancient ones. But both kinds seem to be made of the same whitish clay as our white glazed earthen ware; the modern ones are commonly painted with birds, flowers, &c. The ancient ones are only five inches and a quarter square, and about three-quarters of an inch thick; the modern ones six inches and a half square, and three-quarters of an inch thick.

TYMPAN, or TYMPANUM, in architecture, the area of a pediment, being that part which is on a level with the naked of the friese. Or it is the space included between the three cornishes of a triangular pediment, or the two cornishes of a circular one. Sometimes the tympan is cut out, and the part filled with an iron lattice to give light, and sometimes it is enriched with sculpture in basso relievo.

TYMPAN, among printers, a double frame belonging to the press, covered with parchment, on which the blank sheets are laid in order to be printed off. See PRINTING.

TYMPANUM, or TYMPAN, in mechanics, a kind of wheel placed round an axis, or cylindrical beam, on the top of which are two levers or fixed staves, for the more easy turning the axis, in order to raise a weight required. The tympanum is much the same with the peritrochium, but that the cylinder of the axis of the peritrochium is much shorter, and less than the cylinder of the tympanum.

TYMPANUM *of a machine*, is also used for a hollow wheel, wherein one or more people, or other animals, walk to turn it; such as that of some cranes, calenders, &c.

TYPE, a copy, image, or resemblance of some model. This word is much used among divines, to signify a symbol, sign, or figure of something to come, in which sense it is commonly used with relation to antitype, which is the thing itself, whereof the other is a type or figure.

TYPHA, in botany, a genus of the Monoecia Triandria class and order. Natural order of Calamariæ. Typhæ, Jussieu. Essential character: male, ament cylindrical; calyx indistinct, three leaved, corolla none: female, ament cylindrical, below the males; calyx a villose hair, corolla none; seed one, placed on a capillary down. There are two species, viz. T. latifolia, great cat's-tail, or reed mace, and T. angustifolia, narrow-leaved cat's-tail.

TYPOGRAPHY, the art of printing. See PRINTING and STEREOTYPE.

U.

U, Or u, the twentieth letter, and fifth vowel of our alphabet, is formed in the voice by a round configuration of the lips, and a greater extrusion of the under one than in forming the letter o, and the tongue is also more cannulated. The sound is short in *crust*, *must*, *tun*, *tub*, but is lengthened by a final *e*, as in *tune*, *tube*, &c. In some words it is rather acute than long; as in *brute*, *flute*, *lute*, &c. It is mostly long in polysyllables; as in *union*, *curious*, &c. but in some words it is obscure, as in *nature*, *venture*, &c. This letter, in the form V, or v, is properly a consonant, and as

such is placed before all the vowels; as in *vacant*, *venal*, *vibrate*, &c. Though the letters v and u had always two sounds, they had only the form v till the beginning of the fourth century, when the other form was introduced, the inconvenience of expressing two different sounds by the same letter having been observed long before. In numerals V stands for five, and with a dash added at top, thus $\overline{V}$, it signifies 5,000.

VACCINATION. See SURGERY.

VACCINIUM, in botany, *bilberry*, or *whortleberry*, a genus of the Octandria Monogynia class and order. Natural order of Bicornes. Ericæ, Jussieu. Essential character: calyx superior; corolla one-petalled; filaments inserted into the receptacle; berry four-celled, many seeded. There are twenty-seven species.

VACUUM, in philosophy, denotes a space empty, or devoid, of all matter or body. It has been the opinion of some philosophers, particularly the Cartesians, that nature admits not a vacuum, but that the universe is intirely full of matter: in consequence of which opinion they were obliged to assert, that if every thing contained in a vessel could be taken out or annihilated, the sides of that vessel, however strong, would come together; but this is contrary to experience, for the greatest part of the air may be drawn out of a vessel by means of the air-pump, notwithstanding which it will remain whole if its sides are strong enough to support the weight of the incumbent atmosphere. Should it be objected here, that it is impossible to extract all the air out of a vessel, and that there will not be a vacuum on that account; the answer is, that since a very great part of the air that was in the vessel may be drawn out, as appears by the more quick descent of light bodies in a receiver when exhausted of its air, there must be some vacuities between the parts of the remaining air; which is sufficient to constitute a vacuum. Indeed, to this it may be objected by a Cartesian, that those vacuities are filled with materia subtilis, that passes freely through the sides of the vessel, and gives no resistance to the falling bodies: but as the existence of this materia subtilis can never be proved, we are not obliged to allow the objection, especially since Sir Isaac Newton has found that all matter affords a resistance nearly in proportion to its density. There are many other arguments to prove this, particularly the motions of the comets through the heavenly regions, without any sensible resistance; the different weight of bodies of the same bulk, &c. All the parts of spaces, says Sir Isaac Newton, are not equally full; for if they were, the specific gravity of the fluid which would fill the region of the air, could not, by reason of the exceeding great density of its matter, give way to the specific gravity of quicksilver, gold, or any body, how dense soever: whence neither gold, nor any other body, could descend in the air; for no body can descend in a fluid, unless it be specifically heavier than it. But, if a quantity of matter may, by rarefaction, be diminished in a given space, why may it not diminish in infinitum? And if all the solid particles of bodies are of the same density, and cannot be rarified, without leaving pores, there must be a vacuum.

VADE *mecum*, or VENI *mecum*, a Latin phrase, used in English to express a thing that is very handy and familiar, and which one usually carries about with them; chiefly applied to some favourite book.

VAGINA, properly signifies a sheath, or scabbard: and the term vagina is used in architecture, for the part of a terminus, because resembling a sheath, out of which the statue seems to issue.

VAGINALIS, the *sheath-bill*, in natural history, a genus of birds of the order Grallæ. Generic character: bill strong, thick, compressed; upper mandible covered above with a moveable horny sheath; nostrils placed before the sheath; face naked and papillous; wings with an obtuse excrescence under the flexure; claws grooved. V. alba, or the white sheath-bill, the only species known, is a native of New Zealand and the South Sea Islands. It is in length about sixteen inches. Its food consists of shell fish and putrid carcasses. Its legs are long, red, and naked a little above the knees.

VAGRANTS are all persons threatening to run away and leave their wives and children to the parish. All persons unlawfully returning to the parish or place whence they have been legally removed by order of two justices, without bringing a certificate from the parish or place whereto they belong. All persons who have not wherewith to maintain themselves, live idle, and refuse to work for the usual wages given to other labourers in the like work, in the parishes or places where they are. All persons going from door to door, or placing themselves in the streets, highways, or passages, to beg or gather alms in the parishes

or places where they dwell. All these shall be deemed idle and disorderly persons, and one justice may commit such offenders (being thereof convicted before him, by his own view, confession, or oath of one witness,) to the house of correction, to hard labour, not exceeding one month. And any person may apprehend and carry before a justice, any such persons going from door to door, or placing themselves in the streets, highways, or passages, to beg alms in the parishes or places where they dwell; and if they shall resist, or escape from the person apprehending them, they shall be punished as rogues and vagabonds. And the said justice, by warrant under his hand and seal, may order any overseer, where such offender shall be apprehended, to pay five shillings to any person in such parish or place so apprehending them, for every offender so apprehended; to be allowed in his accounts, or producing the justice's order and the person's receipt to whom it was paid. 17 George II. c. 5. The same statute also enacts, that such justice shall order the person so apprehended to be publicly whipped by the constable, petit-constable, or some other person to be appointed by such constable or petit-constable of the place where such offender was apprehended, or shall order him to be sent to the house of correction; and by 27 George III. c. 11, the common gaol, until the next sessions, or for any less time, as such justice shall think proper. To defray the expenses of apprehending, conveying, and maintaining rogues, vagabonds, and incorrigible rogues, and all other expenses necessary, the justices in sessions, may cause such sums as shall be necessary to be raised, in the same manner as the general county rate. 17 George III. c. 5.

VAHLIA, in botany, so named in honour of Martin Vahl, regius professor of botany, at Copenhagen, a genus of the Pentandria Digynia class and order. Natural order of Succulentæ. Onagræ, Jussieu. Essential character: calyx five-leaved; corolla five-petalled; capsule inferior, one-celled, many-seeded. There is only one species, *viz.* V. capensis, a native of the Cape of Good Hope, in sandy places.

VAIR, in heraldry, a kind of fur, consisting of divers little pieces, argent, and azure, resembling a Dutch U, or a bell-glass. Vairs have their point azure opposite their point argent, and the base argent to the base azure.

VAIRY, VAIRE, VERRY, or VARRY, in heraldry, expresses a coat, or the bearings of a coat, when charged or chequered with vairs: and hence, vary cuppy, or vairy-tassy, is a bearing composed of pieces representing the tops of crutches.

VALANTIA, in botany, *cross-wort*, a genus of the Polygamia Monoecia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: hermaphrodite, calyx none; corolla four-parted; stamens four; style bifid; seed one: male, calyx none; corolla three or four-parted; stamens three or four; pistil obsolete. There are nine species.

VALENTINIA, in botany, a genus of the Octandria Monogynia class and order. Essential character: calyx five-parted, coloured, spreading; corolla none; capsule berried, four-seeded, pulpy. There is but one species, *viz.* V. ilicifolia, a native of Hispaniola, on the most barren rocks towards the ocean; also in Cuba, about the Havannah.

VALERIANA, in botany, *valerian*, a genus of the Triandria Monogynia class and order. Natural order of Aggregatæ. Dipsaceæ, Jussieu. Essential character: calyx none; corolla one-petalled, gibbous on one side of the base, superior; seed one. There are thirty-one species.

VALLISNERIA, in botany, a genus of the Dioecia Diandria class and order. Natural order of Palmæ. Hydrocharides, Jussieu. Essential character: male, spathe two-parted; spadix covered with floscules; corolla three-parted; female, spathe bifid, one-flowered; calyx three-parted, superior; stigma three-parted: capsule one-celled, many-seeded. There are two species, *viz.* V. spiralis, two stamened vallisneria; and V. octandria, eight-stamened vallisneria.

VALUE, in commerce, denotes the price or worth of any thing: hence the intrinsic value denotes the real and effective worth of a thing, and is used chiefly with regard to money, the popular value whereof may be raised and lowered at the pleasure of the prince; but its real, or intrinsic value, depending wholly on its weight and fineness, is not at all affected by the stamp or impression thereon.

VALVE, in hydraulics, pneumatics, &c. is a kind of lid, or cover, of a tube or vessel, so contrived as to open one way; but which, the more forcibly it is pressed the other way, the closer it shuts the aperture; so that it either admits the entrance of a fluid into the tube or vessel, and prevents its return; or admits its escape, and prevents its re-entrance.

VALVE, in anatomy, a thin membrane, applied on several cavities and vessels of the body, to afford a passage to certain humours going one way, and prevent their reflux towards the place from whence they came. The veins and lymphatics are furnished with valves, which open towards the heart, but keep close towards the extremities of those vessels; that is, they let the blood and lymph pass towards the heart, but prevent their returning towards the extreme parts from whence they came.

VAN, in naval affairs, the foremost division of a naval armament, or that part which leads the way to battle, or advances first in the order of sailing.

VANDELLIA, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: calyx four-parted; corolla ringent; filaments the two outer from the disk of the lip of the corolla; anthers connected by pairs; capsule one-celled, many-seeded. There are two species, viz. V. diffusa, and V. pratensis.

VANGUERIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Aggregatæ. Rubiaceæ, Jussieu. Essential character: calyx five-toothed; corolla tube globular, with a hairy throat; stigma bilamellate; berry inferior, four or five seeded. There is but one species, viz. V. edulis, supposed to be a native of China.

VAPOUR, in meteorology, a thin humid matter, which, being rarefied to a certain degree by the action of heat, ascends to a particular height in the atmosphere, where it is suspended, until it returns in the form of dew, rain, snow, &c. On this subject we refer our readers to the articles EVAPORATION and METEOROLOGY, and shall make a few additional observations on dew, which is a phenomenon proper to clear weather. It begins to be deposited about sun-set, is most constant in vallies, and on plains, near rivers, and other collections of waters, and abounds on those parts of the surface which are clothed with vegetation. It is often suspended when rain is approaching, as likewise in windy weather, and before thunder storms; an unusually copious deposition however sometimes precedes rain. The following is said to be the usual appearance in the valley through which the Thames passes. After a clear warm day there is gradually formed on the horizon a continuous haze, rising sometimes to a considerable height, and often tinged by the setting sun with a fine gradation of red and violet shades. This is the precipitated water become faintly visible in its descent. Dew is always to be found on the grass by the time that this haze has become conspicuous, and its abundance is proportioned to the density and permanence of the latter. The following facts are deserving of notice.

In this country the dew is observed more copiously in the mornings of spring and summer than at other times in the year. Sometimes, however, in autumn and winter, an abundant dew is deposited in the night. In countries nearer the equator, the dews are generally observed in the morning throughout the whole year; and in some places they are so very copious as in a great measure to supply the deficiency of rain, which seldom falls in those places. The condensation of the vapour which forms the dew mostly takes place while the sun is below the horizon; the greatest deposition taking place soon after the setting of the sun. In cloudy weather there is little or no dew deposited; the most considerable quantity is observed in a morning, subsequent to a clear, still, and cool night, which has followed a pretty warm day. The lower parts of bodies that are exposed to the ambient air are first covered with dew. The most singular circumstance is, that dew is not deposited upon all kinds of substances indiscriminately: it falls upon certain bodies much more abundantly than on others, and upon some even not at all. The drops of dew attach themselves to glass, crystals, and porcelain, much more readily than to other bodies; next to these come the leaves of vegetables, wood, especially when varnished, and common earthen ware, but the dew adheres least of all to all sorts of metallic bodies. We may now notice Mr. Dalton's observations, which are the result of a variety of well conducted and very accurate experiments on this subject. 1. That aqueous vapour is an elastic vapour *sui generis*, diffusible in the atmosphere, but forming no chemical combination with it. 2. That temperature alone limits the maximum of vapour in the atmosphere. 3. That there exists at all times, and in all places, a quantity of aqueous vapour in the atmosphere, variable according to circumstances. 4. That whatever quantity of aqueous vapour may exist in the atmosphere at any time, a certain temperature may be found, below which a portion of that vapour would unavoidably fall, or be deposited, in the

form of rain or dew, but above which no such diminution could take place with chemical agency. This point may be called the extreme temperature of vapour of that density; and 5. That whenever any body colder than the extreme temperature of the existing vapour is situated in the atmosphere, dew is deposited upon it, the quantity of which varies as the surface of the body, and the degree of cold below the extreme temperature. The reader may be referred to an excellent and elaborate article on this subject in Dr. Rees' New Cyclopedia, a work, of which it may be fairly and honourably said, that, as it advances in its progress, it increases in merit and reputation.

VARIABLE *quantities*, in geometry and analytics, denote such as are either continually increasing or diminishing, in opposition to those which are constant, remaining always the same. Thus, the abscisses and ordinates of an ellipsis, or other curve line, are variable quantities, because they vary or change their magnitudes together. Some quantities may be variable by themselves alone, while those connected with them are constant, as the abscisses of a parallelogram, whose ordinates may be considered as all equal, and therefore constant. The diameter of a circle, and the parameter of a conic section are constant, while their abscisses are variable. Variable quantities, (see FLUXIONS), are usually denoted by the last letters of the alphabet z, y, x, while the constant ones are denoted by the first letters a, b, c.

VARIANCE, in law, signifies any alteration of a thing formerly laid in a plea, or where the declaration in a cause differs from the writ, or from the deed upon which it is grounded. If there be a variance between the declaration and the writ, it is error, and the writ shall abate; and if there appear to be a material variance between the matter pleaded and the manner of pleading it, this is not a good plea, for the manner and matter of pleading ought to agree in substance, or there will be no certainty in it. Cro. Jac. 479.

VARIATION *of curvature*, in geometry, is used for that inequality or change, which happens in the curvature of all curves except the circle; and this variation, or inequality, constitutes the quality of the curvature of any line. Sir Isaac Newton makes the index of the inequality or variation of curvature to be the ratio of the fluxion of the radius of curvature to the fluxion of the curve; and Mr. Maclaurin, to avoid the perplexity that different notions, connected with the same terms, occasion to learners, has adapted the same definition, but he suggests, that this ratio gives rather the variation of the ray of curvature, and that it might have been proper to have measured the variation of curvature, rather by the ratio of the fluxion of curvature itself to the fluxion of the curve; so that the curvature being inversely as the radius of the curvature, and consequently its fluxion as the fluxion of the radius itself directly, and the square of the radius inversely, its variation would have been directly as the measure of it, according to Sir Isaac's definition, and inversely, as the square of the radius of curvature.

VARIATION *of the needle*, in magnetism. Although the north pole of the magnet in every part of the world, when suspended, points towards the northern parts, and the south pole to the southern parts, yet it seldom points exactly north and south. The angle, in which it deviates from due north and south, is called "The variation of the needle," or, "The variation of the compass," and this variation is said to be east or west, according as the north pole of the needle is eastward or westward of the meridian of the place. This deviation from the meridian is not the same in all parts of the world, but is different in different places, and it is almost perpetually varying in the same place. When the variation was first observed, the north pole of the magnetic needle declined eastward of the meridian of London, but it has since that time been changing towards the west; so that in the year 1657, the needle pointed due north and south; at present, it declines towards the west between 24° and 25°, and it seems to be still advancing westward.

VARIEGATION, among botanists and florists, the act of streaking or diversifying the leaves, &c. of plants and flowers with several colours. Variegation is either natural or artificial. Of natural variegation there are four kinds; the first showing itself in yellow spots here and there, in the leaves of plants, called by gardeners the yellow bloach. The second kind, called the white bloach, marks the leaves with a great number of white spots, or stripes; the whitest lying next the surface of the leaves, usually accompanied with other marks of a greenish white, that lie deeper in the body of the leaves. The third, and most beautiful, is where the leaves are edged with white,

being owing to some disorder or infection in the juices, which stains the natural complexion or verdure of the plant. The fourth kind is that called the yellow edge.

VARIGNON (PETER), in biography, was born at Caen in 1654. He was the son of an architect, and intended at an early age for the church. Accident threw into his way a copy of Euclid's Elements, which gave him a strong bias towards mathematical learning. So intent was he in the pursuit of science, that he abridged himself of the necessaries of life, to purchase books to aid him in the pursuit. From his relations he met with much opposition, because they imagined that geometry and algebra would ill accord with the course of theological studies. While he was at college, he became acquainted with the Abbé St. Pierre; and in their application to learning they were mutually serviceable to one another. The abbé, to enjoy more of Varignon's company, determined to lodge with him, and sensible of his merit, he resolved to give him a fortune, that he might fully pursue the bent of his genius, and improve his talents; and out of only 1800 livres a year, which he had himself, he conferred 300 of them upon Varignon.

The abbé, persuaded that he could not do better than go to Paris to study philosophy, settled there in 1686, with M. Varignon, in the suburbs of St. Jacques. There each studied in his own way; the abbé applying himself to the study of men, manners, and the principles of government; whilst Varignon was wholly occupied with the mathematics.

"I," says Fontenelle, "who was their countryman, often went to see them, sometimes spending two or three days with them. They had also room for a couple of visitors, who came from the same province. We joined together with the greatest pleasure. We were young, full of the first ardour for knowledge, strongly united, and, what we were not then perhaps disposed to think so great a happiness, little known. Varignon, who had a strong constitution, at least in his youth, spent whole days in study, without any amusement or recreation, except walking sometimes in fine weather. I have heard him say, that in studying after supper, as he usually did, he was often surprised to hear the clock strike two in the morning; and was much pleased that four hours rest were sufficient to refresh him. He did not leave his studies with that heaviness which they usually create; nor with that weariness which a long application might occasion. He left off gay and lively, filled with pleasure, and impatient to renew it. In speaking of mathematics, he would laugh so freely, that it seemed as if he had studied for diversion. No condition was so much to be envied as his; his life was a continual enjoyment, delighting in quietness."

In the solitary suburb of St. Jacques he formed, however, a connection with many other learned men; as Du Hamel, Du Verney, De la Hire, &c. Du Verney often asked his assistance in those parts of anatomy connected with mechanics: they examined together the positions of the muscles, and their directions; hence Varignon learned a good deal of anatomy from Du Verney, which he repaid by the application of mathematical reasoning to that subject.

At length, in 1687, Varignon made himself known to the public by a treatise on new mechanics, dedicated to the Academy of Sciences. His thoughts on the subject were, in effect, quite new. He discovered truths, and laid open their sources. In this work he demonstrated the necessity of an equilibrium, in such cases as it happens in, though the cause of it is not exactly known. This discovery Varignon made by the theory of compound motions, and is what this essay turns upon. This new treatise on mechanics was greatly admired by the mathematicians, and procured the author two considerable places, the one of geometrician in the Academy of Sciences, the other of professor of mathematics in the college of Mazarine, to this honour he was the first person raised.

Varignon catched eagerly at the science of infinitesimals as soon as it appeared in the world, and became one of its most early cultivators. Severe and unremitted study injured his health very much, and in 1705 he had a dangerous illness, which confined him to his bed many months, and the effects of which he did not recover for three years. Indeed it can scarcely be said that he ever perfectly regained the vigour which he had formerly enjoyed. He could not lay aside his studies, and these were deemed incompatible with his health. He died in 1722: by Fontenelle he is described as an excellent man, not apt to be jealous of the fame of others: he was as simple in his manners as his understanding was superior. He was at the head of the French mathematicians, and one of the best in Europe. He was apt to be over hasty when a new object pre-

sented itself; and too impetuous towards those who opposed him. His works, which were published separately, were "Projet d'une nouvelle Mechanique," 4to. "Des nouvelles Conjecture sur la Pesanteur." "Nouvelle Mechanique ou statique." Besides a vast number of separate memoirs.

VARNISH. Lac varnishes or lacquers consist of different resins in a state of solution, of which the most common are mastich, sandarach, lac, benzoin, copal, amber, and asphaltum. The menstrua are either expressed or essential oils, as also alcohol. For a lac varnish of the first kind, the common painter's varnish is to be united by gently boiling it with some more mastich or colophony, and then diluted again with a little more oil of turpentine. The latter addition promotes both the glossy appearance and drying of the varnish.

Of this sort is the amber varnish. To make this varnish, half a pound of amber is kept over a gentle fire in a covered iron pot, in the lid of which there is a small hole, till it is observed to become soft, and to be melted together into one mass. As soon as this is perceived, the vessel is taken from off the fire, and suffered to cool a little; when a pound of good painter's varnish is added to it, and the whole suffered to boil up again over the fire, keeping it continually stirring. After this, it is again removed from the fire; and when it is become somewhat cool, a pound of oil of turpentine is to be gradually mixed with it. Should the varnish, when it is cool, happen to be yet too thick, it may be attenuated with more oil of turpentine. This varnish has always a dark-brown colour, because the amber is previously half-burned in this operation; but if it be required of a bright colour, amber-powder must be dissolved in transparent painter's varnish, in Papin's machine, by a gentle fire.

As an instance of the second sort of lac-varnishes with ethereal oils alone, may be adduced the varnish made with oil of turpentine. For making this, mastich alone is dissolved in oil of turpentine by a very gentle digesting heat, in close glass vessels. This is the varnish used for the modern transparencies employed as window blinds, fire-screens, and for other purposes. These are commonly prints, coloured on both sides, and afterward coated with this varnish on those parts that are intended to be transparent. Sometimes fine thin calico, or Irish linen, is used for this purpose; but it requires to be primed with a solution of isinglass, before the colour is laid on.

Copal may be dissolved in genuine Chio turpentine, according to Mr. Sheldrake, by adding it in powder to the turpentine previously melted, and stirring till the whole is fused. Oil of turpentine may then be added, to dilute it sufficiently. Or the copal in powder may be put into a long necked matrass with twelve parts of oil of turpentine, and digested several days on a sand-heat, frequently shaking it. This may be diluted with one fourth or one fifth of alcohol. Metallic vessels, or instruments, covered with two or three coats of this, and dried in an oven each time, may be washed with boiling water, or even exposed to a still greater heat, without injury to the varnish.

A varnish of the consistence of thin turpentine is obtained for aërostatic machines, by the digestion of one part of elastic gum, or caoutchouc, cut into small pieces, in thirty-two parts of rectified oil of turpentine. Previously to its being used, however, it must be passed through a linen cloth, in order that the undissolved parts may be left behind.

The third sort of lac-varnishes consists in the spirit-varnish. The most solid resins yield the most durable varnishes; but a varnish must never be expected to be harder than the resin naturally is of which it is made. Hence, it is the height of absurdity to suppose, that there are any incombustible varnishes, since there is no such thing as an incombustible resin. But the most solid resins by themselves produce brittle varnishes: therefore something of a softer substance must always be mixed with them, whereby this brittleness is diminished. For this purpose gum elemi, turpentine, or balsam of capaiva are employed in proper proportions. For the solution of these bodies the strongest alcohol ought to be used, which may very properly indeed be distilled over alkali, but must not have stood upon alkali. The utmost simplicity in composition with respect to the number of the ingredients in a formula is the result of the greatest skill in the art; hence it is no wonder, that the greatest part of the formulas and recipes that we meet with are composed without any principle at all.

In conformity to these rules, a fine colourless varnish may be obtained, by dissolving eight ounces of gum sandarach and two ounces of Venice turpentine in thirty-

two ounces of alcohol by a gentle heat. Five ounces of shell-lac and one of turpentine, dissolved in thirty-two ounces of alcohol by a very gentle heat, give a harder varnish, but of a reddish cast. To these the solution of copal is undoubtedly preferable in many respects. This is effected by triturating an ounce of powder of gum copal, which has been well dried by a gentle heat, with a drachm of camphor, and, while these are mixing together, adding by degrees four ounces of the strongest alcohol, without any digestion.

Between this and the gold varnish there is only this difference, that some substances that communicate a yellow tinge are to be added to the latter. The most ancient description of two sorts of it, one of which was prepared with oil, and the other with alcohol, is to be found in "Alexius Pedemontanus Dei Secreti," Lucca, of which the first edition was published in the year 1557. But it is better prepared, and more durable, when made after the following prescription: Take two ounces of shell lac, of arnatto and turmeric of each one ounce, and thirty grains of fine dragon's blood, and make an extract with twenty ounces of alcohol in a gentle heat.

Oil varnishes are commonly mixed immediately with the colours, but lac or lacquer varnishes are laid on by themselves upon a burnished coloured ground: when they are intended to be laid upon naked wood, a ground should be first given them of strong size, either alone or with some earthy colour, mixed up with it by levigation. The gold lacquer is simply rubbed over brass, tin, or silver, to give them a gold colour.

Pere d'Incarville has informed us, that the tree which affords the varnish of China is called tsi-chou by the Chinese. This tree is propagated by offsets. When the cultivator is desirous of planting it, he takes a branch, which he wraps up in a mass of earth, by means of flax. Care is taken to moisten this earth; the branch pushes out roots, and is then pruned and transplanted. This tree grows to the size of a man's leg.

The varnish is drawn in spring. If it be a cultivated tree, it affords three gatherings. It is extracted by incisions made in the spring; and when the varnish, which is received in shells, does not flow, several hog's bristles, moistened with water or saliva, are introduced into the wound, and cause it to run. When the tree is exhausted, the upper part of it is wrapped in straw, which is set on fire, and causes the varnish to precipitate to the bottom of the tree, where it flows out of perforations made for that purpose.

Those who collect the varnish set out before day-break, and place their shells beneath the apertures. The shells are not left longer than three hours in their place, because the heat of the sun would evaporate the varnish.

The varnish emits a smell, which the workmen are very careful to avoid respiring. It produces an effect which they call the bud of the varnish.

When the varnish issues from the tree it resembles pitch. By exposure to the air, it gradually becomes coloured, and is, at last, of a beautiful black.

The juice which flows from incisions made in the trunk and branches of the rhus toxicodendron possesses the same properties. It is a white milky fluid, which becomes black and thick by the contact of the air.

To make the varnish bright, it is evaporated by the sun; and a body is given to it with hog's gall and sulphate of iron.

The Chinese use the oil of tea, which they render drier by boiling it with orpiment, realgar, and arsenic.

To varnish any substance, consists in applying upon its surface a covering of such a nature, as shall defend it from the influence of the air, and give it a shining appearance.

A coat of varnish ought, therefore, to possess the following properties: 1. It must exclude the action of the air; because wood and metals are varnished to defend them from decay and rust. 2. It must resist water; for otherwise the effect of the varnish could not be permanent. 3. It ought not to alter such colours as are intended to be preserved by this means.

It is necessary, therefore, that a varnish should be easily extended or spread over the surface, without leaving pores or cavities; that it should not crack nor scale; and that it should resist water. Now resins are the only bodies that possess these properties.

Resins, consequently, must be used as the bases of varnish. The question which of course presents itself, must be then, how to dispose them for this use; and for this purpose they must be dissolved, as minutely divided as possible, and combined in such a manner, that the imperfections of these

which might be disposed to scale, may be corrected by others.

Resins may be dissolved by three agents: 1. By fixed oil. 2. By volatile oil. 3. By alcohol. And accordingly we have three kinds of varnish: the fat or oily varnish, essential varnish, and spirit varnish.

Before a resin is dissolved in a fixed oil, it is necessary to render the oil drying. For this purpose the oil is boiled with metallic oxides, in which operation the mucilage of the oil combines with the metal, while the oil itself unites with the oxygen of the oxide. To accelerate the drying of this varnish, it is necessary to add oil of turpentine.

The essential varnishes consist of a solution of resin in oil of turpentine. The varnish being applied, the essential oil flies off, and leaves the resin. This is used only for paintings.

When resins are dissolved in alcohol, the varnish dries very speedily, and is subject to crack; but this fault is corrected by adding a small quantity of turpentine to the mixture, which renders it brighter, and less brittle when dry.

The coloured resins, or gums, such as gamboge, dragon's blood, &c. are used to colour varnishes.

To give lustre to the varnish after it is laid on, it is rubbed with pounded pumice stone and water; which being dried with a cloth, the work is afterward rubbed with an oiled rag and tripoli. The surface is, last of all, cleaned with soft linen cloths, cleared of all greasiness with powder of starch, and rubbed bright with the palm of the hand.

Varnish also signifies a sort of shining coat, wherewith potter's ware, delft-ware, china-ware, &c. are covered, which gives them a smoothness and lustre. Melted lead is generally used for the first, and smalt for the second. See Enamelling.

Varnish, among medalists, signifies the colours antique medals have acquired in the earth. The beauty which nature alone is able to give to medals, and art has never yet attained to counterfeit, enhances the value of them; that is, the colour which certain soils in which they have a long time lain tinges the metals withal; some of which are blue; others with an inimitable vermilion colour; others with a certain shining polished brown, vastly finer than Brasil figures.

VARRONIA, in botany, so named from Marcus Terentius Varro, a genus of the Pentandria Monogynia class and order. Natural order of Asperifoliæ. Borragineæ, Jussieu. Essential character: corolla five-cleft; drupe with a four-celled nut. There are nine species.

VAS, a vessel either for mechanical, chemical, culinary, or any other uses. In anatomy, all the parts which convey a fluid are called vessels, as the veins, arteries, and lymphatics.

VASA *concordiæ*, among hydraulic authors, are two vessels, so constructed as that one of them, though full of wine, will not run a drop, unless the other, being full of water, do run also.

VASE, a term frequently used for ancient vessels dug from under ground, or otherwise found, and preserved in the cabinets of the curious. In architecture, the appellation vase is also given to those ornaments placed on corniches, sochles, or pedestals, representing the vessels of the ancients, particularly those used in sacrifice; as incense-pots, flower-pots, &c. They serve to crown or finish façades, or frontispieces; and hence called acroteria. The term vase, however, is more particularly used in architecture to signify the body of the Corinthian and Composite capital; otherwise called the tambour or drum, and sometimes the campana or bell.

VATERIA, in botany, so named from Abraham Vater, professor of medicine and botany at Witteberg, a genus of the Polyandria Monogynia class and order. Natural order of Guttiferæ, Jussieu. Essential character: calyx five-cleft; corolla five-petalled; capsule three-valved, one-celled, three-seeded. There is only one species; *viz.* V. indica.

VATICA, in botany, a genus of the Dodecandria Monogynia class and order. Natural order of Guttiferæ, Jussieu. Essential character: calyx five-cleft; petals five; anthers fifteen, sessile, four celled. There is but one species, *viz.* V. chinensis, a very rare plant, and as yet scarcely known.

VATICAN, a magnificent palace of the Pope, in Rome, which is said to consist of several thousand rooms; but the parts of it most admired are the grand stair-case, the Pope's apartment, and especially the library, which is one of the richest in the world, both in printed books and manuscripts.

VAULT, in architecture, an arched roof, so contrived that the stones which form it sustain each other. Vaults are, on many occasions, to be preferred to soffits, or flat ceilings, as they give a greater height and

elevation, and are besides more firm and durable.

VECTOR, or *Radius Vector*, in astronomy, is a line supposed to be drawn from any planet moving round a centre, or the focus of an ellipse, to that centre, or focus. It is so called, because it is that line by which the planet seems to be carried round its centre; and with which it describes areas proportional to the times.

VEER, a sea term variously used. Thus veering out a rope, denotes the letting it go by hand, or letting it run out of itself. It is not used for letting out any running rope except the sheet.

VEGETABLE. See BOTANY, PLANT, &c. A vegetable is composed of a root, stem, leaves, flowers, fruits, and seeds; and when all these different parts are fully developed, the vegetable is said to be perfect. When any are deficient, or at least less obvious, the vegetable is said to be imperfect. The root is that part of the plant which is concealed in the earth, and which serves to convey nourishment to the whole plant. The stem, which commences at the termination of the root, supports all the other parts of the plant. When the stem is large and solid, as in trees, it is denominated the trunk, which is divided into the wood and the bark. The bark constitutes the outermost part of the tree, and covers the whole of the plant from the extremity of the roots to the termination of the branches. The bark is composed of three parts, namely the epidermis, the parenchyma, and cortical layers. The epidermis, which is a thin transparent membrane, forming the external covering of the bark, is composed of fibres crossing each other. When the epidermis is removed, it is reproduced. The parenchyma, which is immediately below the epidermis, is of a dark-green colour, composed of fibres crossing each other in all directions, and is succulent and tender.

The cortical layers which constitute the interior part of the bark, are composed of thin membranes, and increase in number with the age of the plant. The wood immediately under the bark, is composed of concentric layers, which increase with the age of the plant, and may be separated into thinner layers which are composed of longitudinal fibres. The wood next the bark, which is softer and whiter, is called the alburnum. The interior part of the trunk is browner and harder, and is denominated the perfect wood.

In the middle of the stem is the pith, which is a soft, spongy substance, composed of cells. In old wood this part entirely disappears, and its place is occupied by the perfect wood.

The leaves are composed of fibres arranged in the form of net-work, which proceed from the stem, and footstalk, by which they are attached to the branches. These fibres form two layers in each leaf, which are destined to perform different functions. The leaves are covered with the epidermis, which is common to the whole of the plant. Each surface of a leaf has a great number of pores and glands, which absorb or emit elastic fluids.

Flowers are composed of different parts. The calyx or cup is formed by the extension of the epidermis; the corolla is a continuation of the bark, and the stamina and pistilla, the internal parts of fructification, are composed of the woody fibres and pith of the plant. Fruits are usually composed of a pulpy, parenchymatous substance, containing a great number of vesicles, and traversed by numerous vessels. Seeds are constituted of the same utricular texture, in the vesicles of which is deposited a pulverulent or mucous substance. These cells have a communication with the plants by means of vessels, and by these is conveyed the necessary nourishment during germination.

Plants contain different orders of vessels, which are distinguished from each other by their course, situation, and uses. Lymphatic vessels serve for the circulation of the sap. They are chiefly situated in the woody part of the plant. The peculiar vessels, which generally contain thick or coloured fluids, are placed immediately under the bark; they are smaller in number than the sap vessels, and have thin interstices filled up with utriculi or cells, with which they form a communication. Some of these proper vessels are situated between the epidermis and the bark, which are readily detected in the spring. Some are situated in the interior part of the bark, forming oval rings, and filled with the peculiar juices of the plant. Another set of proper vessels is placed in the alburnum, nearer the centre of the stock or trunk, and sometimes in the perfect wood. The utriculi or cells constitute another set of vessels, which seem to resemble a flexible tube, slightly interrupted with ligatures at nearly equal distances, but still preserving a free communication through its whole length. They vary in form, colour, and

magnitude in different vegetables, and exist in the roots, the bark, leaves, and flowers. The trachea, or spiral vessels, which are readily detected in succulent plants, appear in the form of fine threads, and may be drawn out to a considerable length without breaking. These vessels are very numerous in all plants, especially under the bark, where they form a kind of ring, and are disposed in distinct bundles, in trees, shrubs, and stalks of herbaceous plants.

VEGETABLE *acids*, in chemistry. The acids which exist in many vegetables are at once recognized by their taste. These acids were formerly denominated essential salts of vegetables, and it was supposed, that all essential salts were the same, and were composed of tartar, or vinegar. But Scheele's discovery of the citric, malic, and gallic acids, which possessing distinct properties from those of tartaric and acetic acids, proved the contrary. Some vegetables contain only one acid, as oranges and lemons, which contain citric acid only. In other vegetables two acids are found, as in gooseberries and currants, the malic, and citric acids; and sometimes three, as the tartaric, citric, and malic acids, which exist together in the pulp of the tamarind. As the acids which exist in vegetables have been already described, under their respective heads, it is now only necessary to enumerate the vegetable acids, specifying at the same time some of the plants from which they are obtained.

Acetic acid has been discovered in the sap of some trees, and in the acid juice of cicer arictinum. Oxalic acid exists in combination with potash, in the leaves of the oxalis acetosella, or wood-sorrel. In other species belonging to the same genus, and in some species of rumex, it is in the state of acidulous oxalate of potash. Oxalate of lime has been found in the root of rhubarb. Citric acid is found in the juice of oranges and lemons, in the berries of two species of vaccinium, &c. Malic acid exists unmixed with other acids, in the apple, the barberry, plumb, sloe, elder, &c. In the gooseberry, in the cherry, strawberry, currants, and some other fruits, malic and citric acids are found nearly in equal proportions. Malic acid has been found mixed with tartaric acid in the agave Americana, and in the pulp of tamarinds, along with citric acid. Vauquelin found it combined with lime, forming a malate of lime, in the sempervivum, tectorum or house-leek. Gallic acid is found in a great number of plants, and in them it exists chiefly in the bark. Benzoic acid is found in benzoin, balsam of Tolu and Peru, liquid styrax, cinnamon, and vanilla. Fourcroy and Vauquelin suspect that it exists in the anthoxanthum odoratum, or sweet-scented grass, which communicates the aromatic flavour to hay. Prussic acid has been found in the leaves of the lauro-cerasus and peach, in bitter almonds, in the kernels of apricots; and it is supposed that it exists also in the kernels of peaches, of plums, and cherries. It is obtained from the kernels of apricots by distilling water off them with a moderate heat; and if lime be added to the concentrated infusion of bitter almonds, a prussiate of lime is formed. Phosphoric acid has been found in different parts of plants; but it is generally combined with lime, forming a phosphate of lime.

VEIN, in anatomy, is a vessel which carries the blood from the several parts of the body to the heart. The veins are composed principally of a membranaceous, a vasculous, and a musculous tunic: but these are vastly thinner than in the arteries. See ARTERY.

VELEZIA, in botany, so named from Christoval Velezius, examiner, first physician, and demonstrator of botany, in the College of Apothecaries at Madrid, a genus of the Pentrandria Digynia class and order. Natural order of Caryophyllei. Caryophylleæ, Jussieu. Essential character: calyx filiform, five-toothed; corolla five-petalled, small; capsule one-celled; seeds numerous, in a single row. There is but one species *viz.* V. rigida, a native of the South of Europe.

VELLA, in botany, a genus of the Tetradynamia Siliculosa class and order. Natural order of Siliquosa or Cruciformes. Cruciferæ, Jussieu. Essential character: silicle with a partition twice as large as the valves, ovate on the outside. There are two species *viz.* V. annua, annual vella, or cress rocket; and V. pseudo cytisus, shrubby vella.

VELOCITY, swiftness, or that affection of motion whereby a moving body is disposed to run over a certain space in a certain time.

In the doctrine of fluxions it is usual to consider the velocity with which magnitudes flow, or are generated. Thus, the velocity with which a line flows, is the same as that of the point, which is supposed to describe or generate the line. The velocity with which a surface flows, is the same as the velocity of a given right line, that,

by moving parallel to itself, is supposed to generate a rectangle, always equal to the surface. The velocity with which a solid flows, may be measured by the velocity of a given plain surface that, by moving parallel to itself, is supposed to generate an erect prism, or cylinder, always equal to the solid. The velocity with which an angle flows, is measured by the velocity of a point, supposed to describe the arc of a given circle, which subtends the angle, and measures it. All these velocities are measured at any term of the time of the motion, by the spaces which would be described in a given time, by these points, lines, or surfaces, with their motions continued uniformly from that term. The velocity with which a quantity flows, at any term of the time, while it is supposed to be generated, is called its fluxion. See FLUXIONS.

VELOCITY *of bodies moving in curves.* According to Galileo's system of the fall of heavy bodies, which is now universally admitted among philosophers, the velocities of a body falling vertically are, at each moment of its fall, as the square roots of the heights from whence it has fallen; reckoning from the beginning of the descent. And hence he inferred, that if a body descend along an inclined plane, the velocities it has, at the different times, will be in the same ratio: for since its velocity is all owing to its fall, and it only falls as much as there is perpendicular height in the inclined plane, the velocity should be still measured by that height, the same as if the fall were vertical. The same principle led him also to conclude, that if a body fall through several contiguous inclined planes, making any angles with each other, much like a stick when broken, the velocity would still be regulated after the same manner, by the vertical heights of the different planes taken together, considering the last velocity as the same that the body would acquire by a fall through the same perpendicular height.

This conclusion continued to be acquiesced in, till the year 1672, when it was demonstrated to be false, by James Gregory, who shows what the real velocity is, which a body acquires by descending down two contiguous inclined planes, forming an obtuse angle, and that it is different from the velocity which a body acquires by descending perpendicularly through the same height; also that the velocity in quitting the first plane, is to that with which it enters the second, and in this latter direction, as radius to the co-sine of the angle of inclination between the two planes.

This conclusion, however, it is observed does not apply to the motions of descent down any curve lines, because the contiguous parts of curve lines do not form any angle between them, and consequently no part of the velocity is lost by passing from one part of the curve to the other; and hence he infers, that the velocities acquired in descending down a continued curve line, are the same as by falling perpendicularly through the same height. This principle is then applied, by the author, to the motion of pendulums and projectiles.

Varignon too, in the year 1693, followed in the same track, showing that the velocity lost in passing from one right lined direction to another, becomes indefinitely small in the course of a curve line; and that therefore the doctrine of Galileo holds good for the descent of bodies down a curve line, *viz*, that the velocity acquired at any point of the curve, is equal to that which would be acquired by a fall through the same perpendicular altitude.

VELVET, a rich kind of stuff, all silk, covered on the outside with a close, short, fine, soft shag, the other side being a very strong close tissue. The nap, or shag, called also the velveting, of this stuff, is formed of part of the threads of the warp, which the workman puts on a long narrow-channeled ruler or needle, which he afterwards cuts, by drawing a sharp steel tool along the channel of the needle to the ends of the warp.

VENEERING, or VANEERING, a kind of inlaying, whereby several thin slices or leaves of fine woods, of different kinds, are applied and fastened on a ground of some common wood. There are two kinds of inlaying: the one, which is the most common and more ordinary, goes no further than the making of compartments of different woods; the other requires much more art, in representing flowers, birds, and the like figures. The first kind is properly called veneering; the latter is more properly called marquetry. The wood used in veneering is first sawed out into slices or leaves about a line in thickness; *i. e.* the twelfth part of an inch. In order to saw them, the blocks, or planks, are placed upright, in a kind of sawing press. These slices are afterwards cut into narrow slips, and fashioned divers ways, according to the design proposed; then the joints having been exactly and nicely adjusted, and the

pieces brought down to their proper thickness, with several planes for the purpose, they are glued down on a ground or block, with good strong glue. The pieces being thus jointed and glued, the work, if small, is put in a press; if large, it is laid on a bench covered with a board, and pressed down with poles or pieces of wood, one end of which reaches to the ceiling of the room, and the other bears on the board. When the glue is thoroughly dry, it is taken out of the press and finished; first with little planes, then with divers scrapers, some of which resemble rasps, which take off the dents, &c. left by the planes. After it has been sufficiently scraped, they polish it with the skin of a sea-dog, wax, and a brush, or polisher of shave-grass; which is the last operation.

VENTER, is used in the law for the children by a woman of one marriage. There is a first and second venter, &c. where a man hath children by several wives.

VENTILAGO, in botany, a genus of the Pentandria Monogynia class and order. Essential character: calyx tubular; corolla scales protecting the stamens, which are inserted into the calyx; samara winged at the top and one seeded. There is only one species, viz. V. maderaspatana.

VENTILATOR, a machine by which the noxious air of any close place, as an hospital, gaol, ship, chamber, &c. may be changed for fresh air.

VENTRE *inspiciendo*, a writ to search a woman that saith she is with child, and thereby withholds lands from the next heir. As if a man, having lands in fee-simple, die, and his widow soon after marry again, and say she is with child by her former husband; in this case, this writ *de ventre inspiciendo* lies for the heir against her; by which writ the sheriff is commanded, that in presence of twelve men, and as many women, he cause examination to be made, whether the woman is with child or not; and if with child, then about what time it will be born; and that he certify the same to the justices of the assize, or at Westminster, under his seal, and under the seals of two of the men present. Cro. Elizabeth, 506. This writ is now granted, not only to an heir at law, but to a devisee, whether for life, in tail, or in fee.

VENTRILOQUISM, an art of speaking, by means of which the human voice and other sounds are rendered audible, as if they proceeded from various different places; though the utterer does not change his place, and in many instances does not appear to speak. It has been supposed to be a natural peculiarity, because few, if any, persons have learned it by being taught; and we have had no rules laid down for acquiring it. It seems to have been in consequence of this notion that the name ventriloquism has been applied to it, from a supposition that the voice proceeds from the thorax or chest. It has seldom been practised but by persons of the lower classes of society; and as it does not seem to present any advantages beyond that of causing surprize and entertainment, and cannot be exhibited on an extended theatre, the probability is that it will continue amongst them.

Mr. Gough, in the Manchester Memoirs, and in various parts of Nicholson's Journal, has entertained the opinion that the voice of ventriloquists is made to proceed, in appearance, from different parts of a room by the management of an echo. But the facts themselves do not support this hypothesis, as a great and sudden variety and change of echoes would be required; and his own judicious remarks, in the same work, on the facility with which we are deceived as to the direction of sound, are adverse to his theory. From numerous attentive observations, it appears manifest that the art is not peculiar to certain individuals, but may with facility be acquired by any person of accurate observation. It consists merely in an imitation of sounds, as they occur in nature, accompanied with appropriate action of such a description as may best concur in leading the minds of the observers to favour the deception.

Any one who shall try, will be a little surprised to find how easy it is to imitate the noise made by a saw, or by a snuff-box when opened or shut, or by a large hand-bell, or a cork cutter's knife, a watch while going, and numberless other inanimate objects; or the voices of animals in their various situations and necessities, such as a cat, a dog, or an hen enraged, intimidated, confined, &c.; or to vary the character of the human voice by shrillness or depth of tone, rapidity or drawling of execution, and distinctness or imperfection of articulating, which may be instantly changed by holding the mouth a little more open or more closed than usual, altering the position of the jaw, keeping the tongue in any determinate situation, &c. And every one of the imitations of the ventriloquists will be rendered more perfect by practising

very time the sounds are heard, depending on the memory. The condition of performance is that the and sounds of the dramatic dialogue exhibited, should succeed each other rapidly that the audience should lose ght of the probability that one actor gives effect to the whole, and that where the business is simple the aid of scenery or local circumstance should be called in.

We have seen an eminent philosopher of our own time, who had no previous practice of this art, but when speaking on the subject in a mixed company, took up an hat and folding the flaps together said, by way of example, "Suppose I had a small monkey in this hat;" and then cautiously putting his hand in, as if to catch it, he imitated the chatter of the supposed struggling animal, at the same time that his own efforts to secure it had a momentary impression on the spectators, which left no time for them to question whether there was a monkey in it or not: this impression was completed when, the instant afterwards, he pulled out his hand as if hurt, and exclaimed "he has bit me." It was not till then that the impression of reality gave way to the diversion arising from the mimic art; and one of the company, even then, cried out "Is there really a monkey in the hat?"

In this manner it was that, at the beginning of the last century, the famous Tom King, who is said to have been the first man who gave public lectures on experimental philosophy in this country, was attended by the whole fashionable world, for a succession of many nights, to hear him "kill a calf." This performance was done in a separated part of the place of exhibition, into which the exhibitor retired alone; and the imagination of his polite hearers was taxed to supply the calf and three butchers, besides a dog who sometimes raised his voice and was checked for his unnecessary exertions. It appears, from traditional narrative, that the calf was heard to be dragged in, not without some efforts and conversation on the part of the butchers, and noisy resistance from the calf; that they conversed on the qualities of the animal, and the profits to be expected from the veal; and that, as they proceeded, all the noises of knife and steel, of suspending the creature, and of the last fatal catastrophe, were heard in rapid succession, to the never-failing satisfaction of the attendants; who, upon the rise of the curtain, saw that all these imaginary personages had vanished, and Tom King alone remained to claim the applause.

A similar fact may be quoted in the person of that facetious gentleman who has assumed and given celebrity to the name of Peter Pindar. This great poet, laughing at the proverbial poverty of his profession, is sometimes pleased to entertain his friends with unexpected effusions of the art we speak of. One of these is managed by a messenger announcing to the Doctor (in the midst of company) that a person wants to speak with him: he accordingly goes out, leaving the door a-jar, and immediately a female voice is heard, which, from the nature of the subject, appears to be that of the Poet's laundress, who complains of her pressing wants, disappointed claims, and of broken promises no longer to be borne with patience. It is more easy to imagine than describe the mixed emotions of the audience. The scene, however, goes on by the Doctor's reply; who remonstrates, promises, and is rather angry at the time and place of this unwelcome visit. His antagonist unfortunately is neither mollified nor disposed to quit her ground. Passion increases on both sides, and the Doctor forgets himself so far as to threaten the irritated female; she defies him, and this last promise, very unlike the former ones, is followed by payment; a severe slap on the face is heard; the poor woman falls down stairs, with horrid outcries; the company, of course, rises in alarm; and the Doctor is found in a state of perfect tranquillity, apparently a stranger to the whole transaction.

A very able ventriloquist, Fitz James, performed in public, in Soho Square, about four years ago. He personated various characters by appropriate dresses; and by a command of the muscles of his face he could very much alter his appearance. He imitated many inanimate noises, and among others, the repetition of noises of the water-machine at Marli. He conversed with some statues, which replied to him; and also with some persons supposed to be in the room above, and on the landing place; gave the watchman's cry, gradually approaching, and when he seemed opposite the window, Fitz-James opened it and asked what the time was, received the answer, and during his proceeding with his cry, Fitz-James shut the window, immediately upon which the sound became weaker, and at last insensible. In the whole of his performance it was clear that the notions of the audience were governed by the auxiliary

circumstances, as to direction, &c. This mimic had, at least, six different habitual modes of speaking, which he could instantly adopt one after the other, and with so much rapidity, that when in a small closet, parted off in the room, he gave a long, confused, and impassioned debate of Democrats (in French, as almost the whole of his performance was); it seemed to proceed from a multitude of speakers: and an inaccurate observer might have thought that several were speaking at once. A ludicrous scene of drawing a tooth was performed in the same manner.

These examples, and many more which might be added, are sufficient, in proof, that ventriloquism is the art of mimicry, an imitation applied to sounds of every description, and attended with circumstances which produce an entertaining deception, and lead the hearers to imagine that the voice proceeds from different situations. When distant, and consequently low voices are to be imitated, the articulation may be given with sufficient distinctness, without moving the lips, or altering the countenance. It was by a supposed supernatural voice of this kind, from a ventriloquist, that the famous musical small-coal man, Thomas Britton, received a warning of his death, which so greatly affected him that he did not survive the affright.

VENUE, the neighbourhood from whence juries are to be summoned for trial of causes. In local actions, as of trespass and ejectment, the venue is to be from the neighbourhood of the place, where the lands in question lie; and in all real actions the venue must be laid in the county where the thing is for which the action is brought; but in transitory actions, for injuries that may have happened any where, as debt, detinue, slander, or the like, the plaintiff may declare in what county he pleases, and then the trial must be in that county in which the declaration is laid. Though if the defendant will make affidavit that the cause of action, if any, arose not in that, but in another county, the court will direct a change of the venue, and oblige the plaintiff to declare in the proper county. And the court will sometimes move the venue from the proper jurisdiction (especially of the narrow and limited kind), upon a suggestion duly supported, that a fair and impartial trial cannot be had therein. With respect to criminal cases, it is ordained by statute 21 James I. c. 4, that all informations on penal statutes shall be laid in the counties where the offences were committed.

VENUS, the most beautiful star in the heavens, known by the names of the morning and evening star, likewise keeps near the sun, though she recedes from him almost double the distance of Mercury. She is never seen in the eastern quarter of the heavens when the sun is in the western; but always seems to attend him in the evening, or to give notice of his approach in the morning. The planet Venus presents the same phenomena with Mercury: but her different phases are much more sensible, her oscillations wider, and of longer duration. Her greatest distance from the sun varies from 45° to nearly 48°, and the mean duration of a complete oscillation is 584 days. Venus has been sometimes seen moving across the sun's disc in the form of a round black spot, with an apparent diameter of about 59″. A few days after this has been observed, Venus is seen in the morning, west of the sun, in the form of a fine crescent, with the convexity turned toward the sun. She moves gradually westward with a retarded motion, and the crescent becomes more full. In about ten weeks she has moved 46° west of the sun, and is now a semicircle, and her diameter is 26″. She is now stationary. She then moves eastward with a motion gradually accelerated, and overtakes the sun about 9½ months after having been seen on his disc. Sometime after, she is seen in the evening, east of the sun, round, but very small. She moves eastward, and increases in diameter, but loses of her roundness, till she gets about 46° east of the sun, when she is again a semicircle. She now moves westward, increasing in diameter, but becoming a crescent like the waning moon; and, at last, after a period of nearly 584 days, comes again into conjunction with the sun with an apparent diameter of 59″. She does not move exactly in the plane of the ecliptic, but deviates from it several degrees. Like Mercury, she sometimes crosses the sun's disc. The duration of these transits, as observed from different parts of the earth's surface, are very different: this is owing to the parallax of Venus, in consequence of which different observers refer to different parts of the sun's disc, and see her describe different chords on that disc. In the transit which happened in 1769, the difference of its duration, as observed at Otaheite and at Wardhuys in Lapland, amounted to 23 minutes, 10 se-

conds. This difference gives us the parallax of Venus, and of course her distance from the earth during a conjunction. The knowledge of this parallax enables us, by a method to be afterwards described, to ascertain that of the sun, and consequently to discover its distance from the earth. The great variations of the apparent diameter of Venus demonstrate that her distance from the earth is exceedingly variable. It is largest when the planet passes over the surface of the sun. Her mean apparent diameter is 58″.

Venus, as we have already observed, is occasionally seen in the disc of the sun, in form of a dark round spot. This happens when the earth is about her nodes at the time of her inferior conjunction. These appearances, called transits, happen but very seldom. During the last century there were two transits, one in June, 1761, and the other in 1769: no other will occur till the writers and most of the present readers of this Dictionary shall be no more, *viz.* in 1874. Excepting such transits as these, Venus exhibits the same appearances to us regularly every eight years; her conjunctions, elongations, and times of rising and setting being very nearly the same, on the same days, as before. From the transit of Venus in 1761 was deduced the sun's parallax, and of course his distance from the earth with very great accuracy. See Philosophical Transactions, vol. li. and lii. On the day of the transit, when the sun was nearly at his greatest distance from the earth, the parallax was found to be 8″ 52‴; therefore, at his mean distance, it will be 8″ 65‴. Whence, by logarithms, we have 10,000, &c.—5.622 (sine of 8″ 65‴) = 4.376 = 23882.84, the number of semidiameters of the earth contained in its distance from the sun. This last number, multiplied by 3985, the number of miles in the earth's semi-diameter, gives 95,173,122 miles for the mean distance of the earth from the sun. This being obtained, we easily, by calculation, find the distances of all the other planets. Other observers made the parallax somewhat different, but it was generally admitted that this distance is somewhere between 95 and 96 millions of miles.

Venus, in natural history, a genus of the Vermes Testacea class and order. Animal a tethys; shell bivalve, the frontal margin flattened with incumbent lips; hinge with three teeth, all of them approximate, the lateral ones divergent at the tip. There are nearly two hundred species, in sections. A. Shell somewhat heart-shaped. B. Orbicular. These are found in different parts of the world. V. verrucosa inhabits the Mediterranean, English, and Antilly coasts: thick, two inches long, and as much broad; sometimes marked with a few brown spots and rays.

VERATRUM, in botany, a genus of the Polygamia Monoecia class and order. Natural order of Coronariæ. Junci, Jussieu. Essential character: calyx none; corolla six-petalled; stamina six: hermaphrodite, pistils three; capsule many-seeded: male, rudiment of a pistil. There are four species.

VERB. See GRAMMAR.

VERBASCUM, in botany, *mullein*, a genus of the Pentandria Monogynia class and order. Natural order of Luridæ. Solaneæ, Jussieu. Essential character: corolla wheel-shaped, a little unequal; capsule two-celled, two-valved. There are nineteen species.

VERBENA, in botany, *vervain*, a genus of the Diandria Monogynia class and order. Natural order of Personatæ. Vitices, Jussieu. Essential character: corolla funnel-shaped, almost equal, curved; calyx one of the teeth truncate; seeds two or four, naked, or very thinly arilled; stamina two or four. There are twenty-three species.

VERBESINA, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: calyx a double row; florets of the ray about five; pappus awned; receptacle chaffy. There are twelve species.

VERDICT, the answer of a jury made upon any cause, civil or criminal, committed by the court to their examination; and this is two fold, general or special. A general verdict is that which is given or brought into the court in like general terms to the general issue; as, guilty or not guilty generally. A special verdict is, when they say at large that such a thing they find to be done by the defendant, or tenant, so declaring the course of the fact, as in their opinion it is proved; and as to the law upon the fact, they pray the judgment of the court: and this special verdict, if it contain any ample declaration of the cause from the beginning to the end, is also called a verdict at large. A special verdict is usually found where there is any difficulty or doubt respecting the laws, when the jury state the

facts as proved, and pray the advice of the court thereon. A less expensive and more speedy mode, however, is, to find a verdict generally for the plaintiff, subject, nevertheless, to the opinion of the judge, or the court above, or a special case drawn up and settled by counsel on both sides.

VERDITER, a kind of mineral substance, sometimes used by the painters, &c. for a blue; but more usually mixed with a yellow for a green colour.

VERDOY, in heraldry, denotes a bordure of a coat of arms, charged with any kinds or parts of flowers, fruits, seeds, plants, &c.

VERGE, signifies the compass of the King's court, which bounds the jurisdiction of the Lord Steward of the Household; and which is thought to have been twelve miles round.

The term verge is also used for a stick or rod, whereby one is admitted tenant to a copyhold estate, by holding it in his hand, and swearing fealty to the lord of the manor.

VERGERS, certain officers of the courts of King's Bench and Common Pleas, whose business it is to carry white wands before the judges.

There are also vergers of cathedrals and collegiate churches, who carry a rod tipped with silver before the bishop, dean, &c.

VERGETTE, in heraldry, denotes a pallet, or small pale; and hence, a shield divided by such pallets, is termed vergette.

VERJUICE, a liquor obtained from grapes or apples, unfit for wine or cyder; or from sweet ones, whilst yet acid and unripe. Its chief use is in sauces, ragouts, &c. though it is also an ingredient in some medicinal compositions, and is used by the wax-chandlers to purify their wax.

VERMES, in natural history, the last class of the animal kingdom, according to the Linnæan system. The animals in this class are not merely those commonly known by the name of worms, but likewise those which have the general character of being "slow in motion, of a soft substance, extremely tenacious of life, capable of re-producing such parts of their body as may have been taken away or destroyed, and inhabiting moist places." There are five orders in this class, viz. the

Infusoria	Testacea
Intestina	Zoophyta
Mollusca	

These animals are generally considered as the lowest in the scale of animated being. The simplicity of their form, the humility of their station, and the low degree of sense and motion which they seem to enjoy, have rendered them objects of but little attention to mankind in general, excepting as they contribute to the supply of their wants, or to render themselves formidable, by the pain and distress which they occasion to those bodies which nature seems to have destined for their habitation. But, to the curious investigator of the ways of heaven, every part of the vast creation becomes interesting, and this class of animated beings, has, in later times, attracted a considerable share of attention. To this they seem fully entitled, if we consider the number of animals which are included under the general name of worms: if we observe the simplicity of form in some of them, and the complicated structure of others; in short, if we reflect on the various modes in which they are propagated, and on the surprising faculty, which many of them possess, of spontaneous reproduction: the imagination will be astonished with their number and variety, and confounded by their wonderful properties. The waters are peopled with myriads of animated beings, which, though invisible to our unassisted eyes, are unquestionably endowed with organs as perfect as the largest animals, since, like these, they re-produce others similar to themselves, and hold in the scale of nature a rank as little equivocal, though less obvious and obtrusive. The elegance of form, and beauty of colour, which some of the "mollusca," and "zoophyta" possess, cannot fail to render them objects of admiration to the most indifferent observer.

VERMICELLI, a composition of flour, cheese, yolks of eggs, sugar, and saffron, reduced to a paste, and formed into long slender pieces, like worms, by forcing it with a piston through a number of little holes

VERNIER, a scale adapted for the graduation of mathematical instruments, so called from Pierre Vernier the inventor. Under the article BAROMETER will be seen some account of this scale as applied to that instrument, here we shall take it up more generally.

This scale is derived from the following principle. If two equal right lines, or circular arcs, A B, are so divided, that the number of equal divisions in B is one less than the number of equal divisions in A, then

will the excess of one division of A be compounded of the ratios of one of A to A, and of one of B to B. For, let A contain 11 parts, then one of A to A is as 1 to 11, or $\frac{1}{11}$. Let B contain 10 parts, then one of B to B is as 1 to 10, or $\frac{1}{10}$. Now $\frac{1}{10}-\frac{1}{11}$ $=\frac{11-10}{10\times 11}=\frac{1}{10\times 11}=\frac{1}{10}\times\frac{1}{11}$.

Or if B contains n parts, and A contains $n+1$ parts; then $\frac{1}{n}$ is one part of B, and $\frac{1}{n+1}$ is one part of A. And $\frac{1}{n}-\frac{1}{n+1}=$ $\frac{\overline{n+1}-n}{n\times\overline{n+1}}=\frac{1}{n}\times\frac{1}{n+1}$.

The most commodious divisions, and their aliquot parts, into which the degrees on the circular limb of an instrument may be supposed to be divided, depend on the radius of that instrument.

Let R be the radius of a circle in inches; and a degree to be divided into n parts, each being $\frac{1}{p}$ th part of an inch.

Now the circumference of a circle, in parts of its diameter 2 R inches, is 3.1415926 $\times$ 2 R inches.

Then $360° : 3.1415926 \times 2\,R :: 1° : \frac{3.1415926}{360}\times 2\,R$ inches.

Or, $0.01745329 \times R$ is the length of one degree in inches.

Or, $0.01745329 \times R \times p$ is the length of 1°, in pth parts of an inch.

But as every degree contains n times such parts, therefore $n = 0.01745329 \times R \times p$.

The most commodious perceptible division is $\frac{1}{8}$ or $\frac{1}{10}$ of an inch.

Example. Suppose an instrument of 30 inches radius, into how many convenient parts may each degree be divided? how many of these parts are to go to the breadth of the vernier, and to what parts of a degree may an observation be made by that instrument?

Now, $0.01745 \times R = 0.5236$ inches, the length of each degree: and if p is supposed about $\frac{1}{8}$ of an inch for one division; then $0.5236 \times p = 4.188$ shows the number of such parts in a degree. But as this number must be an integer, let it be 4, each being 15′; and let the breadth of the vernier contain 31 of those parts, or $7\frac{3}{4}°$, and be divided into 30 parts.

Here $n=\frac{1}{4}$; $m=\frac{1}{30}$; then $\frac{1}{4}\times\frac{1}{30}=\frac{1}{120}$ of a degree, or 30′, which is the least part of a degree that instrument can show.

If $n=\frac{1}{5}$, and $m=\frac{1}{36}$; then $\frac{1}{5}\times\frac{1}{36}=\frac{60}{5\times 36}$ of a minute, or 20″.

VERONICA, in botany, *speedwell*, a genus of the Diandria Monogynia class and order. Natural order of Personatæ. Pediculares, Jussieu. Essential character: corolla four-cleft, wheel-shaped, with the lowest segment narrower; capsule superior, two-celled. There are fifty-seven species.

VERSED *sine of an arch*, a segment of the diameter of a circle, lying between the foot of a right sine, and the lower extremity of the arch.

VERT, in heraldry, the term for a green colour. It is called vert in the blazon of the coats of all under the degree of nobles; but in coats of nobility, it is called emerald; and in those of kings, Venus. In engraving, it is expressed by diagonals, or lines drawn athwart from right to left, from the dexter chief corner to the sinister base.

VERT, or GREEN HUE, in forest law, any thing that grows and bears a green leaf within the forest, that may cover a deer. This is divided into over-vert and nether-vert; over-vert is the great woods which, in law-books, are usually called hault-bois; nether-vert is the under woods, otherwise called sub-bois. We sometimes also meet with special vert, which denotes all trees growing in the King's woods within the forest; and those which grow in other men's woods, if they be such trees as bear fruit to feed the deer.

VERTEBRÆ, in anatomy, the twenty-four bones of which the spine consists, and on which the several motions of the trunk of our bodies are performed.

VERTEX is used, in astronomy, for the point of heaven perpendicularly over our heads, properly called the zenith.

VERTICAL *circle*, in astronomy, a great circle of the sphere, passing through the zenith and nadir, and cutting the horizon at right angles: it is otherwise called azimuth.

VERTICAL *prime*, is that vertical circle or azimuth which passes through the poles of the meridian; or which is perpendicular to the meridian, and passes through the equinoctial points.

Vertical *plane*, in perspective, is a plane perpendicular to the geometrical plane, passing through the eye, and cutting the perspective plane at right angles.

Vertical *plane*, in conics, is a plane passing through the vertex of the cone, and parallel to any conic section.

VESPA, in natural history, *the wasp*. Mouth horny, with a compressed jaw; feelers four, unequal, filiform; antennæ filiform, the first joint longer and cylindrical; eyes linear; body glabrous; upper wings folded in each sex; sting pungent, concealed in the abdomen. More than two hundred species have been enumerated, divided into three sections, which are again divided into sub-sections. A. Tongue simple; or without any. B. Tongue bifid, retractile. C. Tongue inflected, and five cleft. Wasps live mostly in numerous societies, constructing curious nests, or combs, generally under ground; they prey upon other insects, especially bees and flies, and devour meal, bread, and fruit; the larva is soft, without feet, and feeds on the nectar of flowers and honey; the pupa quiescent, and has the rudiments of wings. V. vulgaris, or common wasp, is well known to every one. The nest of this species is a highly curious structure, and is prepared beneath the surface of some dry bank, or other convenient situation. Its shape is that of an upright oval, often measuring ten or twelve inches at least in diameter: it consists of several horizontal stages or stories of hexagonal cells, the interstices of each story being connected at intervals by upright pillars; and the exterior surface of the nest consists of a great many layers or pieces, disposed over each other in such a manner as best to secure the interior cavity from the effects of cold and moisture; the whole nest, comprising both walls and cells, is composed of a substance very much resembling the coarser kinds of whitish-brown paper, and consists of the fibres of various dry vegetable substances, agglutinated by a tenacious fluid, discharged from the mouths of the insects during their operations. The female wasps deposit their eggs in the cells, one in each cell appropriated for that purpose; from these are hatched the larva, or maggots, which bear a near resemblance to those of bees: they are fed by the labouring wasps with a coarse kind of honey, and when arrived at their full size, close up their respective cells with a fine tissue of silken filaments, and, after a certain period, emerge in their complete or perfect form. The male insect, like the male bee, is destitute of a sting. The society or swarm of the common wasp, consists of a vast number of neutral or labouring insects, a much smaller number of males, and still fewer females. They do not, like bees, prepare and lay up a store of honey for winter use; but the few which survive the season of their birth, remain torpid during the colder months.

V. crabo, the hornet, is a species of a far more formidable nature than the common wasp, and is of considerably larger size: its colour is a tawny yellow, with ferruginous and black bars, and variegations. The nest of this species is generally built in the cavity of some decayed tree, or immediately beneath its roots; and not unfrequently in timber yards and other similar situations. It is of smaller size than that of the wasp, and of a somewhat globular form, with an opening beneath; the exterior shell consisting of more or few layers of the same strong paper-like substance with that prepared by the wasp: the cells are also of a similar nature, but much fewer in number, and less elegantly composed. The hornet, like the wasp, is extremely voracious.

VESPERTILIO, the *bat*, in natural history, a genus of Mammalia, of the order Primates. Generic character: teeth erect, sharp-pointed, approximated; fore-feet palmated, with a membrane surrounding the body, and by which the animal is enabled to fly. Bats fly only by night, in quest of their food, consisting of gnats and moths, and when deprived of their eyes, appear to feel no want of them, having a supplemental power of perception, by which they avoid objects in the way with nearly as much precision as in their perfect state. In cold climates they pass the winter in torpor, assembling in holes and in caverns, in which they are occasionally seen adhering in great numbers to the walls, and sometimes suspended by their hind legs. The bones of the extremities of the fore legs of bats are continued into long and thin processes, connected by a fine and almost transparent skin, which they are enabled to unfold optionally, for flight, or to withdraw into a very small compass, when they wish to repose. The general division is into those which have tails, and those which have none. There are twenty-five species.

V. murinus, or the common bat, is two inches and a half long, including its tail, and nine wide, and is of a reddish-brown

colour, with black wings and ears, the last rounded and small. It is found almost throughout Europe. When on the ground, it is frequently unable to rise, without ascending some eminence for the greater convenience of managing its wings.

V. auritus, or the great-eared bat, is distinguished from the former by the size of its ears, which are more than an inch long. This is very common in England, and its manners, food, and size are similar to those of the former. These animals are stated to take their drink, as well as food, while upon the wing, as they flutter over streamlets or ponds, which they often do for the insect food so copiously supplied by these situations. On the river Thames, in a fine evening in summer, they may occasionally be seen to the number of several scores, or even hundreds, in one view. By the ancients the bat was consecrated to the goddess of the infernal regions, and its general aspect, and nocturnal flights, and leathern wings, render it not an inappropriate inhabitant of those obscure and dismal territories. These animals are capable of being tamed, and have been brought to feed from a person's hand. In one instance of this kind, they shewed extreme dexterity in clearing flies of their wings, which they always refuse. They partook of raw flesh, but preferred insects; and, in taking their nourishment, they were desirous to avoid observation, and for this purpose stretched round their wings before their mouth. They occasionally ran, but with extreme aukwardness.

V. spectrum, or the spectre bat, is found in South America, and is a large species, its wings extending nearly two feet and a quarter. Its chief residence is in palm-trees.

V. vampyrus, or the vampyre bat, is an inhabitant of India and South America, is about twelve inches long, and the extent of its wings is four feet, and in some extraordinary instances, it is said, six. Its tongue is pointed, and terminated by sharp prickles. It is reported to suck the blood of cattle, by inserting the point of its tongue into one of their veins during sleep, so as to excite little or no pain. This is said to be done by them with respect to men also. Various writers, of general respectability, concur in these statements, and have observed, that in some parts of South America, and in India, it is, on this account, highly dangerous to sleep in the open air, or in apartments with open windows. This property of sucking the blood of human beings, has long been affirmed of the bats of Europe; but though assertions of this nature are incapable of being contradicted, there does not appear to be any detail of well authenticated facts in their support. The two last species have no tail.

VESTA, one of the small planetary bodies discovered lately to revolve between the planets Mars and Jupiter: the following account is taken from the "Philosophical Transactions."

"At our very first observations, with magnifying powers of 150 and 300, applied to the excellent new fifteen-feet reflector, we found the planet Vesta, without any appearance of a disc, merely as a point, like a fixed star, with an intense, radiating light, and exactly of the same appearance as that of any fixed star of the sixth magnitude. In the same manner we both afterwards saw this planet several times with our naked eyes, when the sky was clear, and when it was surrounded by smaller invisible stars, which precluded all possibility of mistaking it for another. This proves how very like the intense light of this planet is to that of a fixed star. As the observations and measurements of Ceres, Pallas, and Juno, were made with the same eye-glasses, but with the thirteen-feet reflector, we soon after compared the planet Vesta with the same glasses of 136 and 288 times magnifying power in the thirteen-feet reflector. In both these telescopes its image was, without the least difference, that of a fixed star of the sixth magnitude, with an intense radiating light; so that this new planet may, with the greatest propriety, be called an asteroid.

"April 26th, in the evening, at nine o'clock, true time, I succeeded in effecting the measurement of Vesta, with the same power of 288, by means of the thirteen-feet reflector, with which that of Ceres, Pallas, and Juno had been made; and when viewed by this reflector, it also appeared exactly in the same manner. Of several illuminated discs, of 2.0 to 0.5 decimal lines, which I had before made use of for measuring the satellites of Saturn and Jupiter, the smallest disc only of 0.5 lines could be used for this purpose; by it the rounded nucleus of the planet Vesta, when the disc was at the distance of 611.0 lines from the eye, appeared almost of the same size, and I must even estimate its diameter as one-sixth smaller. If, therefore, we attend, not to the full magnitude of the projection, but the estimation just mentioned, it follows,

by calculation, that the apparent diameter of the planet Vesta is only 0.488 seconds, and consequently, only half of what I have found to be the apparent diameter of the fourth satellite of Saturn. This extraordinary smallness, with such an intense, radiant, and unsteady light of a fixed star, is the more remarkable, as, according to the preliminary calculations of Dr. Gauss, there can be no doubt that this planet is found in the same region between Mars and Jupiter, in which Ceres, Pallas, and Juno perform their revolutions round the sun; that, in close union with them, it has the same cosmological origin; and that, as a planet of such smallness and of so very intense light, it is comparatively near to the earth. This remarkable circumstance will no doubt be productive of important cosmological observations, as soon as the elements of the new planet have been sufficiently determined, and its distance from the earth ascertained by calculation."

Much of what is said of Vesta is applicable to the other small planetary bodies referred to in this article.

VESTRY, a place adjoining to a church, where the vestments of the minister are kept; also a meeting at such place, where the minister, churchwardens, and principal men of most parishes, at this day, make a parish vestry. On the Sunday before a vestry is to meet, public notice ought to be given, either in the church, or after divine service is ended, or else at the church door, as the parishioners come out; both of the calling of the meeting, and also the time and place of the assembling of it; and it is reasonable then also to declare for what business the meeting is to be held, that none may be surprised, but that all may have full time before, to consider of what is to be proposed at the meeting.

VESUVIAN, in mineralogy, a species of the Flint genus; it is of a dark olive-green, which passes into a blackish green. It occurs massive, often crystallized. Specific gravity about 3.5. Before the blow pipe, it melts, without addition, into a yellowish and faintly-translucent glass. It is found among the exuviæ of Vesuvius, in a rock composed of mica, hornblende, garnet, and calc spar, which Werner imagines to constitute part of the primitive mass on which that volcanic mountain rests. It has also been found in Siberia, and in Kamtschatka. At Naples it is cut into ring stones, and is sold under various names. Two specimens have been analyzed by Klaproth; the results are as follow:

Vesuvian of Vesuvius.

Silica	35.50
Lime	33.00
Allumina	22.25
Oxide of iron	7.50
Oxide of manganese	0.25
Loss	1.50
	100.00

Vesuvian of Siberia.

Silica	42.00
Lime	34.00
Allumina	16.25
Oxide of iron	5.50
Loss	2.25
	100.00

VESUVIUS, a famous volcano, or burning mountain, situated only six miles east of the city of Naples, in Italy. See VOLCANO.

VIBRATION, in mechanics, a regular reciprocal motion of a body, as, for example, a pendulum, which, being freely suspended, swings or vibrates from side to side. Mechanical authors, instead of vibration, often use the term oscillation, especially when speaking of a body that thus swings by means of its own gravity or weight.

The vibrations of the same pendulum are all isochronal; that is, they are performed in an equal time, at least, in the same latitude; for in lower latitudes they are found to be slower than in higher ones. See PENDULUM. In our latitude, a pendulum 39⅛ inches long vibrates seconds, making 60 vibrations in a minute.

The vibrations of a longer pendulum take up more time than those of a shorter one, and that in the sub-duplicate ratio of the lengths, or the ratio of the square roots of the lengths. Thus, if one pendulum be 40 inches long, and another only 10 inches long, the former will be double the time of the latter in performing a vibration; for $\sqrt{40} : \sqrt{10} :: \sqrt{4} : \sqrt{1}$, that is, as 2 to 1. And because the number of vibrations, made in any given time, is reciprocally as the duration of one vibration, therefore the number of such vibrations is in the reciprocal subduplicate ratio of the lengths of the pendulums.

VIBRATIONS *of a stretched chord, or string*, arise from its elasticity; which

power being in this case similar to gravity, as acting uniformly, the vibrations of a chord follow the same laws as those of pendulums. Consequently the vibrations of the same chord, equally stretched, though they be of unequal lengths, are isochronal, or are performed in equal times; and the squares of the times of vibration are to one another inversely as their tensions, or powers by which they are stretched. The vibrations of a spring, too, are proportional to the powers by which it is bent. These follow the same laws as those of the chord and pendulum; and consequently are isochronal, which is the foundation of spring-watches.

VIBRATIONS are also used in physics, &c. and for several other regular alternate motions. Sensation, for instance, is supposed to be performed by means of the vibratory motion of the contents of the nerves, begun by external objects, and propagated to the brain. This doctrine has been particularly illustrated by Dr. Hartley, who has extended it further than any other writer, in establishing a new theory of our mental operations. The same ingenious author also applies the doctrine of vibrations to the explanation of muscular motion, which he thinks is performed in the same general manner as sensation and the perception of ideas. For a particular account of his theory, and the arguments by which it is supported, see his "Observations on Man," vol. 1.: see also Belsham's "Elements;" and "Introductory Essays to Hartley," by Dr. Priestley.

VIBRIO, in natural history, a genus of the Vermes Infusoria class and order. Worm invisible to the naked eye, very simple, round, elongated. There are twenty species, described by Adams, and other authors on the microscope.

VIBURNUM, in botany, *laurustinus*, a genus of the Pentandria Trigynia class and order. Natural order of Dumosæ. Caprifolia, Jussieu. Essential character: calyx five-parted, superior; corolla five-cleft; berry one seeded. There are twenty-three species.

VICAR, one who supplies the place of another. The priest of every parish is called rector, unless the prædial tithes are appropriated, and then he is stiled vicar; and when rectories are appropriated, vicars are to supply the rector's place. For the maintenance of the vicar, there was then set apart a certain portion of the tithes, commonly about a third part of the whole, which are now what are called the vicarial tithes, the rest being reserved to the use of those houses which, for the like reason, are termed the rectorial tithes.

VICARAGE. For the most part vicarages were endowed upon appropriations; but sometimes vicarages have been endowed without any appropriation of the parsonage; and there are several churches where the tithes are wholly impropriated, and no vicarage endowed; and there, the impropriators are bound to maintain curates to perform divine service, &c. The parsons, patron, and ordinary, may create a vicarage and endow it; and in time of vacancy of the church, the patron and ordinary may do it; but the ordinary alone cannot create a vicarage, without the patron's assent.

VICE, in smithery, and other arts employed in metals, is a machine, or instrument, serving to hold fast any thing they are at work upon, whether it is to be filed, bent, riveted, &c. To file square, it is absolutely necessary that the vice be placed perpendicular, with its chaps parallel to the work-bench.

VICE, *hand*, is a small kind of vice serving to hold the lesser works in, that require often turning about. Of these there are two kinds: the broad-chapped hand-vice, which is that commonly used; and the square-nosed hand-vice, seldom used but for filing small round work.

VICE is also a machine used by the glaziers to turn or draw lead into flat rods, with grooves on each side to receive the edges of the glass.

VICE is also used, in the composition of divers words, to denote the relation of something that comes instead, or in the place, of another; as vice-admiral, vice-chancellor, vice-chamberlain, vice-president, &c. are officers who take place in the absence of admirals, &c. See the article ADMIRAL, &c.

VICIA, in botany, *vetch*, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: stigma transversely bearded on the lower side. There are twenty-five species.

VICINAGE, in law, common of vicinage is, where the inhabitants of two townships, which lie contiguous, have usually intercommoned with one another, the beasts of the one straying mutually into the other's

fields without any molestation from either. This, indeed, is only a permissive right, intended to excuse what, in strictness, is a trespass in both, and to prevent a multiplicity of suits; and therefore either township may inclose and bar out the other, though they have intercommoned time out of mind. Neither has any person of one town a right to put his beasts, originally, into the other's common; but if they escape and stray there of themselves, the law does not punish trespass.

VI ET ARMIS, *with force and arms*, in law, are words used in indictments, declarations, &c. to express the charge of forcible and violent committing any crime or trespass; but on appeal of death, on a killing with a weapon, the words *vi et armis* are not necessary, because they are implied; so in an indictment of forcibly entry alleged to have been made *manu forti*, &c.

VIETA (FRANCIS), in biography, a very celebrated French mathematician, was born in 1540, at Fontenai, a province of France. Among other branches of learning in which he excelled, he was one of the most respectable mathematicians of the sixteenth century, or indeed of any age. His writings abound with marks of great originality, and the finest genius, as well as intense application. His application was such, that, it is said, he has sometimes remained in his study for three days together, without eating or sleeping. His inventions and improvements, in all parts of the mathematics, were very considerable. He was in a manner the inventor and introducer of specious algebra, in which letters are used instead of numbers. He made also considerable improvements in geometry and trigonometry. He gave some masterly tracts on trigonometry, both plane and spherical, which may be found in the collection of his works, published at Leyden in 1646, by Schooten, besides another large and separate volume in folio, published in the author's life time, at Paris, in 1579, containing extensive trigonometrical tables, with the construction and use of the same. To this complete treatise on trigonometry, plane and spherical, are subjoined several miscellaneous problems and observations, such as, the quadrature of the circle, the duplication of the cube, &c. Computations are here given of the ratio of the diameter of a circle to the circumference, and of the length of the sign of one minute, both to a great many places of figures; by which he found that the sine of one minute is

between 2908881959
and 2908882056

also the diameter of a circle, being 1000, &c. that the perimeter of the inscribed and circumscribed polygon of 393216 sides, will be as follows, viz. the

Perimeter of the inscribed polygon	31415926535
Perimeter of the circumscribed polygon	31415926537

and that therefore the circumference of the circle lies between those two numbers.

Vieta was also a profound decypherer, an accomplishment that proved very useful to his country. As the different parts of the Spanish monarchy lay very distant from one another, when they had occasion to communicate any secret designs, they wrote them in ciphers and unknown characters, during the disorders of the league: the cipher was composed of more than 500 different characters, which yielded their hidden contents to the penetrating genius of Vieta alone. His skill so disconcerted the Spanish councils for two years, that they published it at Rome, and other parts of Europe, that the French King had only discovered their ciphers by means of magic. He died at Paris, in the year 1603, in the sixty-third year of his age.

VIEW, in law, is generally where a real action, or an action of trespass, is brought in any of the Courts of Record at Westminster, and it shall appear to the court to be proper and necessary that the jurors should have a view, they may order special writs of *distringas*, or *habeas corpora*, to issue, commanding the sheriff to have six of the first twelve of the jurors therein named, or of some greater number of them, at the place in question, &c. This is done where it is of any importance to the determination of the cause, to be acquainted with the local situation and actual state of the place injured.

VILLAIN, or VILLEIN, in our ancient customs, denotes a man of servile and base condition, *viz.* a bondman or servant: and there were anciently two sorts of bondmen or villains in England: the one termed a villain in gross, who was immediately bound to the person of his lord and his heirs; the other a villain regardant to a manor, he being bound to his lord as a member be-

longing and annexed to the manor whereof the lord was owner; and he was properly a pure villain, of whom the lord took redemption to marry his daughter, and to make him free; and whom the lord might put out of his lands and tenements, goods and chattels, at his will, and beat and chastise, but not maim him.

VINCULUM, in algebra, a mark or character, either drawn over, or including, or some other way accompanying, a factor, divisor, dividend, &c. when it is compounded of several letters, quantities, or terms, to connect them together as one quantity, and show that they are to be multiplied, or divided, &c. together. Vieta first used the bar or line over the quantities, for a vinculum, thus $\overline{a+b}$; and Albert Girard the parenthesis, thus $(a+b)$; the former way being now chiefly used by the English, and the latter by most other Europeans. Thus $\overline{a+b} \times c$, or $(a+b) \times c$, denotes the product of c and the sum $a+b$ considered as one quantity. Also $\sqrt{\overline{a+b}}$, or $\sqrt{(a+b)}$, denotes the square root of the sum $a+b$. Sometimes the mark : is set before a compound factor, as a vinculum, especially when it is very long, or an infinite series: thus $3a \times : 1 - 2x + 3x^2 - 4x^3 + 5x^5$, &c.

VINE. See VITIS.

VINCA, in botany, *periwinkle*, a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Apocineæ, Jussieu. Essential character: contorted; follicles two, erect; seeds naked. There are five species.

VINEGAR is a liquor of an agreeable smell, a pleasant and strongly-acid taste, and of a hue varying from light-red to brown-straw colour; and is prepared by fermenting any substance or compound which has already undergone the spirituous fermentation. Vinegar, therefore, may be made immediately from any wine, malt liquor, cyder, &c.; or from the juice of the grape and other fruits; from infusion of malt, or any saccharine liquid, through the intermedium of vinous fermentation. Both these methods are actually practised with complete success. To make vinegar out of a liquor containing suitable materials, it is only necessary, 1st, to allow some access of air to the vessel in which it is kept; and, 2d, to keep it in a temperature rather higher than that of the atmosphere in this climate, that is to say, about 75° to 80°. It is also almost essential, where a liquor already fermented is employed, to add a portion of yeast, or any other ferment; for though any fermented liquor, if kept in a moderate temperature in an open vessel, will spontaneously run sour, or become changed to vinegar; this change is too gradual to produce this acid in perfection, and the first acetified portion turns mouldy before the last has become sour: but where the substance employed has not yet undergone fermentation, the whole process of the vinous and subsequent acetous fermentation will go on uninterruptedly with the same ferment which at first set it in action, which happens, for example, in the making vinegar from malt, or from sugar and water. In this country vinegar is chiefly made from malt. The following is the usual process in London: A mash of malt and hot water is made, which, after infusion for an hour and a half, is conveyed into a cooler, a few inches deep, and thence, when sufficiently cooled, into large and deep fermenting tuns, where it is mixed with yeast, and kept in fermentation for four or five days. The liquor (which is now a strong ale without hops) is then distributed into smaller barrels, set close together in a stoved chamber, and a moderate heat is kept up for about six weeks; during which the fermentation goes on equally and uniformly till the whole is soured. This is then emptied into common barrels, which are set in rows (often of many hundreds) in a field in the open air, the bung-hole being just covered with a tile, to keep off the wet but to allow a free admission of air. Here the liquor remains for four or five months, according to the heat of the weather, a gentle fermentation being kept up till it becomes perfect vinegar. This is finished in the following way: Large tuns are employed, with a false bottom, on which is put a quantity of the refuse of raisins, or other fruit, left by the makers of raisin and other home-made wines, called technically rape. These rape-tuns are worked by pairs; one of them is quite filled with the vinegar from the barrels, and the other only three-quarters full, so that the fermentation is excited more easily in the latter than the former; and every day a portion of the vinegar is laded from one to the other, till the whole is completely finished, and fit for sale. Vinegar, as well as fruit-wines, is often made in small quantity for domestic uses, and the process is by no means difficult. The materials may be either brown sugar and water alone, or sugar with raisins, cur-

rants, and especially ripe gooseberries: these should be mixed in the proportions which would give a strong wine, put into a small barrel, which it should fill about three-fourths, and the bung-hole very loosely stopped. Some yeast, or, what is better, a toast sopped in yeast, should be put in, and the barrel set in the sun in summer, or a little way from a fire in winter, and the fermentation will soon begin. This should be kept up constant, but very moderate, till the taste and smell indicate that the vinegar is complete. It should be poured off clear, and bottled carefully; and it will keep much better if it is boiled for a minute, cooled, and strained before bottling. Vinegar contains a considerable quantity of colouring extractive matter, from which it can only be freed by distillation, the process of which will be clearly understood by a reference to the article DISTILLATION. See also ACETIC *acid*. When vinegar is long kept, especially exposed to the air, it becomes muddy, acquires a mouldy, unpleasant smell, loses its clear red colour and all its properties, and finally, is changed to a slimy mucilage and water.

VIOL, in music, a stringed instrument, resembling in shape and tone the violin, of which it was the origin.

VIOLA, in botany, *violet*, a genus of the Syngenesia Monogamia class and order. Natural order of Campanaceæ. Cisti, Jussieu. Essential character: calyx five-leaved; corolla five-petalled, irregular, horned at the back; anthers cohering; capsule superior, one-celled, three-valved. There are forty three species: some of these plants are highly esteemed, particularly the V. odorata, sweet violet, for its fragrance; it is a native of every part of Europe, in woods, among bushes, in hedges, and on warm banks, flowering early in the spring.

VIOLIN. See MUSICAL *instruments*.

VIOLONCELLO. See MUSICAL *instruments*.

VIPER. See COLUBER.

VIRECTA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Rubiaceæ, Jussieu. Essential character: calyx five-toothed, with teeth interposed; corolla funnel-form; stigma two parted; capsule one celled, many-seeded, inferior. There are two species, viz. V. biflora, two-flowered virecta, and V. pratensis.

VIRGO, in astronomy, one of the signs or constellations of the zodiac, and the sixth according to order. It is marked thus ♍, and in Ptolemy's catalogue consists of thirty-two stars, in Tycho's of thirty-nine, and in the Britannic of eighty-nine.

VIRTUAL *focus*, in optics, is a point in the axis of a glass, where the continuation of a refracted ray meets it.

VIS, a Latin word, signifying force or power, adopted by physical writers to express divers kinds of natural powers or faculties. Vis impressa is defined, by Sir Isaac Newton, to be the action exercised on any body, to change its state, either in resisting, or moving uniformly in a right line. This force consists altogether in the action, and has no place in the body, after the action is ceased. See INERTIA, &c.

VISCUM, in botany, *misseltoe*, a genus of the Dioecia Tetrandria class and order. Natural order of Aggregatæ, Linnæus. Caprifolia, Jussieu. Essential character: male, calyx four-parted; corolla none; filaments none; anthers fastened to the calyx: female, calyx four-leaved, superior; corolla none; style none, berry one-seeded; seed cordate. There are twelve species.

VISIBLE, something that is an object of sight or vision, or something whereby the eye is affected, so as to produce a sensation.

The Cartesians say that light alone is the proper object of vision. But according to Newton, colour alone is the proper object of sight; colour being that property of light by which the light itself is visible, and by which the images of opaque bodies are painted on the retina. Philosophers in general had formerly taken for granted, that the place to which the eye refers any visible object, seen by reflection or refraction, is that in which the visual ray meets a perpendicular from the object upon the reflecting or the refracting plane. That this is the case with respect to plane mirrors is universally acknowledged; and some experiments with mirrors of other forms seem to favour the same conclusion, and thus afford reason for extending the analogy to all cases of vision. If a right line be held perpendicularly over a convex or concave mirror, its image seems to make one line with it. The same is the case with a right line held perpendicularly within water; for the part which is within the water seems to be a continuation of that which is without. But Dr. Barrow called in question this method of judging of the place of an object, and so opened a new field of inquiry and debate in this branch of science. This,

with other optical investigations, he published in his Optical Lectures, first printed in 1674. According to him, we refer every point of an object to the place from which the pencils of light issue, or from which they would have issued, if no reflecting or refracting substance intervened. Pursuing this principle, Dr. Barrow proceeded to investigate the place in which the rays issuing from each of the points of an object, and that reach the eye after one reflection or refraction, meet; and he found that when the refracting surface was plane, and the refraction was made from a denser medium into a rarer, those rays would always meet in a place between the eye and a perpendicular to the point of incidence. If a convex mirror be used, the case will be the same; but if the mirror be plane, the rays will meet in the perpendicular, and beyond it, if it be concave. He also determined, according to these principles, what form the image of a right line will take when it is presented in different manners to a spherical mirror, or when it is seen through a refracting medium.

M. Bouguer adopts Barrow's general maxim, in supposing that we refer objects to the place from which the pencils of rays seemingly converge at their entrance into the pupil. But when rays issue from below the surface of a vessel of water, or any other refracting medium, he finds that there are always two different places of this seeming convergence: one of them of the rays that issue from it in the same vertical circle, and therefore fall with different degrees of obliquity upon the surface of the refracting medium; and another of those that fall upon the surface with the same degree of obliquity, entering the eye laterally with respect to one another. He says, sometimes one of these images is attended to by the mind, and sometimes the other; and different images may be observed by different persons. And he adds, that an object plunged in water affords an example of this duplicity of images.

From the principle above illustrated, several remarkable phenomena of vision may be accounted for: as—That if the distance between two visible objects be an angle that is insensible, the distant bodies will appear as if contiguous: whence, a continuous body being the result of several contiguous ones, if the distances between several visibles subtend insensible angles, they will appear one continuous body; which gives a pretty illustration of the notion of a continuum. Hence also parallel lines, and long vistas, consisting of parallel rows of trees, seem to converge more and more the further they are extended from the eye; and the roofs and floors of long extended alleys seen, the former to descend, and the latter to ascend, and approach each other; because the apparent magnitudes of their perpendicular intervals are perpetually diminishing, while at the same time we mistake their distance. See Priestley's Light and Colours.

The mind perceives the distance of visible objects, 1st, From the different configurations of the eye, and the manner in which the rays strike the eye, and in which the image is impressed upon it. For the eye disposes itself differently, according to the different distances it is to see; viz. for remote objects the pupil is dilated, and the crystalline brought nearer the retina, and the whole eye is made more globous; on the contrary, for near objects, the pupil is contracted, the crystalline thrust forwards, and the eye lengthened. Again, the distance of visible objects is judged of by the angle the object makes; from the distinct or confused representation of the objects; and from the briskness or feebleness, or the rarity or density of the rays. To this it is owing, 1st, That objects which appear obscure or confused, are judged to be more remote; a principle which the painters make use of to cause some of their figures to appear further distant than others on the same plane. 2d, To this it is likewise owing, that rooms whose walls are whitened, appear the smaller; that fields covered with snow, or white flowers, appears less than when clothed with grass; that mountains covered with snow, in the night time, appear the nearer, and that opaque bodies appear the more remote in the twilight.

The magnitude of visible objects, is known chiefly by the angle contained between two rays drawn from the two extremes of the object to the centre of the eye. An object appears so large as is the angle it subtends; or bodies seen under a greater angle, appear greater; and those under a less angle, less, &c. Hence the same thing appears greater or less as it is nearer the eye or further off. And this is called the apparent magnitude. But to judge of the real magnitude of an object, we must consider the distance: for since a near and a remote object may appear under equal angles, though the magnitudes be different, the distance must necessarily be estimated, because the magnitude is great or small according as the distance is. So

that the real magnitude is in the compound ratio of the distance and the apparent magnitude; at least when the subtended angle, or apparent magnitude, is very small; otherwise, the real magnitude will be in a ratio compounded of the distance and the sine of the apparent magnitude, nearly, or nearer still its tangent. Hence, objects seen under the same angle, have their magnitudes in the same ratio as their distances. The chord of an arc of a circle appears of equal magnitude from every point in the circumference, though one point be vastly nearer than another. Or if the eye be fixed in any point in the circumference, and a right line be moved round so as its extremes be always in the periphery, it will appear of the same magnitude in every position. And the reason is, because the angle it subtends is always of the same magnitude. And hence also, the eye being placed in any angle of a regular polygon, the sides of it will all appear of equal magnitude; being all equal chords of a circle described about it. If the magnitude of an object directly opposite to the eye be equal to its distance from the eye, the whole object will be distinctly seen, or taken in by the eye, but nothing more. And the nearer you approach an object, the less part you see of it. The least angle under which an ordinary object becomes visible, is about one minute of a degree.

The figure of visible objects is estimated chiefly from our opinion of the situation of the several parts of the object. This opinion of the situation, &c. enables the mind to apprehend an external object under this or that figure, more justly than any similitude of the images in the retina, with the object can; the images being often elliptical, oblong, &c, when the objects they exhibit to the mind are circles, or squares, &c.

The laws of vision, with regard to the figures of visible objects, are. 1. That if the centre of the eye be exactly in the direction of a right line, the line will appear only as a point. 2. If the eye be placed in the direction of a surface, it will appear only as a line. 3. If a body be opposed directly towards the eye, so as only one plane of the surface can radiate on it, the body will appear as a surface. 4. A remote arch, viewed by an eye in the same plane with it, will appear as a right line. 5. A sphere, viewed at a distance, appears a circle. 6. Angular figures, at a distance, appear round. 7. If the eye look obliquely on the centre of a regular figure, or a circle, the true figure will not be seen; but the circle will appear oval, &c.

VISION, is the act of seeing or of perceiving external objects by the organ of sight. As every point of an object, A B C, (Plate XVI. Miscel. fig. 11.), sends out rays in all directions, some rays from every point on the side next the eye, will fall upon the cornea, between E and F, and by passing on through the humours and pupil of the eye, they will be converged to as many points on the retina, or bottom of the eye, and will thereon form a distinct inverted picture, *c b a*, of the object. Thus the pencil of rays, *q r s*, that flows from the point, A, of the object, will be converged to the point, *a*, on the retina; those from the point, B, will be converged to the point *b*; those from the point, C, will be converged to the point, *c*; and so of all the intermediate points, by which means the whole image, *a b c*, is formed, and the object made visible, although it must be owned that the method by which the sensation is carried from the eye by the optic nerve to the common sensory in the brain, and there discerned, is above the reach of our conception. That vision is effected in this manner may be demonstrated experimentally. Take a bullock's eye, while it is fresh, and having cut off the three coats from the back part, quite to the vitreous humour, put a piece of white paper over that part, and hold the eye towards any bright object, and you will see an inverted picture of the object upon the paper. The diameters of images at the bottom of the eye are proportional to the angles which the objects subtend at the eye, the same as in a lens, and are reciprocally as the distances of the same object viewed in different places. The eye is in reality no more than a camera obscura, for the rays of light flowing from all the points of an object, through the pupil of the eye, do by the refraction of its humours, paint the image thereof in the bottom of the eye: just so it is in the camera obscura, where all the rays refracted by a lens in the window shutter, or passing through a small hole in it, paint the image on the opposite wall. Some properties of the eye are these: the eye can only see a very small part of an object distinctly at once. For the collateral parts of an object are not represented distinctly in the eye; and therefore the eye is forced to turn itself successively to the several parts of the object it wants to view, that they may fall near the axis of the eye, where alone distinct vision is performed.

When any point of an object is seen distinctly with both eyes, the axis of both eyes are directed to that point, and meet there; and then the object appears single, though looked at with both eyes; for the optic nerves are so framed, that the correspondent parts in both eyes lead to the same place in the brain, and give but one sensation, and the image will be twice as bright with both eyes as with one. But if the axis of both eyes be not directed to the object, that object will appear double, as the pictures in the two eyes do not fall upon correspondent or similar parts of the retina. The best eye can hardly distinguish any object that subtends at the eye an angle less than half a minute, and very few can distinguish it when it subtends a minute. If the distance of two stars in the heavens be not greater than this, they will appear as one. Though men may see distinctly at different distances, by altering the position and figure of the crystalline, yet they can only see distinctly within certain limits, and nearer than that, objects appear confused. But these limits are not the same in different people. A good eye can see distinctly when the rays fall parallel upon it, and then the principal focus is at the bottom of the eye, a man can judge at a small distance, with a single eye, by frequently observing how much variation is made in the eye to make the object distinct, and from this a habit of judging is acquired. But this cannot be done at great distances, because, though the distance be varied, the change in the eye becomes then insensible. But a man can judge of greater distances with both eyes, than he can with one. For the eyes being at a distance from one another, as long as that distance has a sensible proportion to the distance of the object, one gets a habit of judging, by the position of the axis of the eyes, which are always directed to that point. For different distances require different positions of the axis, which depend on the motions of the eyes, which we feel. But in very great distances no judgment can be made from the motion of the eyes, or their internal parts. Therefore we can only guess at the distances from the magnitude, colour, and the position of interjacent bodies. Dimness of sight generally attends old people, and this may arise from two causes. 1. By the eyes growing flat, and not uniting the rays at the retina, which causes indistinctness of vision; or, 2. By the opacity of the humours of the eye, which in time lose their transparency, in some degree; from whence it follows that a great deal of the light that enters the eye, is stopped and lost; and every object appears faint and dim. Hence the necessity of spectacles.

If objects are seen through a perfectly flat glass, the rays of light pass through it from them to the eye, in a straight direction, and parallel to each other, and consequently the objects appear very little either diminished or enlarged, or nearer, or further off, than to the naked eye; but if the glass they are seen through have any degree of convexity, the rays of light are directed from the circumference towards the centre, in an angle proportional to the convexity of the glass, and meet in a point, at a greater or lesser distance from the glass, as it is more or less convex. This point, where the rays meet, is called the focus, and this focus is nearer or further off, according to the convexity of the glass; for as a little convexity throws it to a considerable distance, so when the convexity is much, the focus is very near. Its magnifying power is also in the same proportion to the convexity; for as a flat glass scarcely magnifies at all, the less a glass departs from flatness, the less of course it magnifies; and the more it approaches towards the globular figure, the nearer its focus is, and the more its magnifying power. People's different length of sight depends on the same principle, and arises from more or less convexity of the cornea and crystalline humour of the eye; the rounder these are, the nearer will the focus or point of meeting rays be, and the nearer an object must be brought to see it well. The case of short sighted people is only an over-roundness of the eye, which makes a very near focus; and that of old people is a sinking or flattening of the eye, whereby the focus is thrown to a great distance, so that the former may properly be called eyes of too short, and the latter eyes of too long a focus. Hence too, the remedy for the last is a convex glass, to supply the want of convexity in the eye itself, and brings the rays to a shorter focus; whereas a concave glass is needful for the first to scatter the rays and prevent their coming to a point too soon. The nearer any object can be brought to the eye, the larger will be the angle under which it appears, and the more it will be magnified. Now, that distance from the naked eye, where the generality of people are supposed to see small objects best, is about six inches, con-

sequently, when such objects are brought nearer than six inches, they will become less distinct; and if to four or three, they will scarce be seen at all. But by the help of convex glasses we are enabled to view things clearly at much shorter distances than these; for the nature of a convex lens is to render an object distinctly visible to the eye at the distance of its focus; wherefore the smaller a lens is, and the more its convexity, the nearer is its focus, and the more its magnifying power. Now, it is evident from the figure, that if either the cornea, or crystalline humour, or both of them, be too flat, their focus will not be on the retina, where it ought to be, in order to render vision distinct, but beyond the eye. Consequently those rays which flow from the object, and pass through the humours of the eye, are not sufficiently converged to unite, and therefore the observer can have but a very indistinct view of the object. This is remedied by placing a convex glass, of a proper focus, before the eye, which makes the rays converge sooner, and imprints the image duly on the retina. If either the cornea or crystalline humour, or both of them, be too convex, the rays that enter in from the object will be converged to a focus in the vitreous humour, and by diverging from thence to the retina, will form a very confused image thereon, and so of course, the observer will have as confused a view of the object, as if his eye had been too flat. This inconvenience is remedied by placing a concave glass before the eye, which glass, by causing the rays to diverge between it and the eye, lengthens the focal distance, so that if the glass be properly chosen, the rays will unite at the retina, and form a distinct picture of the object upon it.

VISMEA, in botany, a genus of the Dodecandria Trigynia class and order. Natural order of Onagræ, Jussieu. Essential character: calyx five-leaved, inferior; corolla five-petalled; stigmas five; nut two or three-celled, half inferior. There is but one species, *viz.* V. mocanera, a native of the Canary islands.

VISUAL, in general, something belonging to vision. Thus, rays of light, coming from an object to the eye, are called visual rays; and the visual point in perspective is a point in the horizontal line, wherein all the visual rays unite.

VITAL *air*. See OXYGEN *gas*.

VITEX, in botany, *chaste-tree*, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Vitices, Jussieu. Essential character: calyx five-toothed; corolla-border six-cleft; drupe one-seeded; a four-celled nut. There are fourteen species.

VITIS, in botany, the *vine*, a genus of the Pentandria Monogynia class and order. Natural order of Hederaceæ. Vitices, Jussieu. Essential character: petals cohering at the top, shrivelling; berry five-seeded, superior. There are twelve species, and many varieties.

The most important species of the vitis is V. vinifera, or common vine, which has naked, lobed, sinuated leaves. There are a great many varieties; and all the sorts are propagated either from layers, or cuttings; the latter method is said to be preferable, though the former is much used in this country.

The uses of the fruit of the vine for making wine, &c. are well known. The vine was introduced by the Romans into Britain, and appears formerly to have been very common. From the name of vineyard yet adhering to the ruinous scites of our castles and monasteries, there seem to have been few in the country but what had a vineyard belonging to them. The county of Gloucester is particularly commended by Malmsbury, in the twelfth century, as excelling all the rest of the kingdom in the number and goodness of its vineyards. In the earlier periods of our history, the isle of Ely was expressly denominated the isle of Vines by the Normans. Vineyards are frequently noticed in the descriptive accounts of Doomsday; and those of England are even mentioned by Bede, as early as the commencement of the eighth century.

Doomsday exhibits to us a particular proof that wine was made in England during the period preceding the conquest; and after the conquest, the bishop of Ely appears to have received at least three or four tons of wine annually as tithes, from the produce of the vineyards in his diocese, and to have made frequent reservations in his leases of a certain quantity of wine for rent. A plot of land in London, which now forms East Smithfield and some adjoining streets, was withheld from the religious house within Aldgate by four successive constables of the tower, in the reigns of Rufus, Henry, and Stephen, and made by them into a vineyard, which yielded great emolument. In the old accounts of rectorial and vicarial revenues, and in the old registers of ecclesiastical suits concerning them,

the tithe of wine is an article that frequently occurs in Kent, Surry, and other counties. And the wines of Gloucestershire, within a century after the conquest, were little inferior to the French in sweetness. The beautiful region of Gaul, which had not a single vine in the days of Cæsar, had numbers so early as the time of Strabo. The south of it was particularly stocked with them; and they had even extended themselves into the interior parts of the country; but the grapes of the latter did not ripen kindly. France was famous for its vineyards in the reign of Vespasian, and even exported its wines to Italy. The whole province of Narbonne was then covered with vines; and the wine-merchants of the country were remarkable for knavish dexterity, tinging it with smoke, colouring it (as was suspected) with herbs and noxious dyes, and even adulterating the taste and appearance with aloes. And as our first vines would be transplanted from Gaul, so were in all probability those of the Allobroges in Franche-compté. These were peculiarly fitted for cold countries. They ripened even in the frosts of the advancing winter; and they were of the same colour, and seem to have been of the same species, as the black muscadines of the present day, which have lately been tried in this island, and found to be the fittest for the climate. These were brought into Britain a little after the vines had been carried over all the kingdoms of Gaul, and about the middle of the third century, when the numerous plantations had gradually spread over the face of the latter.

VITMANNIA, in botany, so named in honour of Abbé F. Vitmann, professor at Milan, a genus of the Octandria Monogynia class and order. Essential character: calyx four-cleft; corolla four-petalled; nectary a scale at the base of each filament; nut semi-lunar, compressed, one-seeded. There is but one species, *viz.* V. elliptica, a native of the East Indies.

VITRIOL, *natural*, in mineralogy, a species of fossil salts, divided into three subspecies. 1. Iron vitriol. 2. Copper vitriol. 3. Zinc vitriol.

The iron vitriol is of an emerald and verdigrease green, sometimes bordering on sky-blue; sometimes on grass green. It occurs massive, tuberose, stalactitic, and crystallized. It occurs usually with iron pyrites, by the decomposition of which it is formed. It is found in many parts of Germany, Italy, Sweden, and in many of the English mines, in Teneriffe, and Greenland. It is employed to dye linen yellow, and wool and silk black; it is also of use in the manufacture of ink, of Berlin blue, for the precipitation of gold from its solution; and sulphuric acid can be obtained from it by distillation, and the residuum, called calcothar of iron, is used as a red paint, and when washed, for polishing steel, glass, &c.

Copper vitriol is of a dark sky-blue colour, which sometimes approaches to verdigris green. It occurs massive, disseminated, stalactitic, dentiform, and crystallized. If a plate of iron be inserted in a solution of copper vitriol, it soon becomes incrusted with metallic copper. With ammonia its solution acquires a blue colour. It is found in many parts of Germany, Sweden, and Siberia, in the copper mines of Ireland, and in Anglesea, in Wales. It is used in cotton and linen printing, and the oxide is separated from it, and used as a pigment.

Zinc vitriol is of a greyish colour, and found also in Germany and Sweden.

VITRUVIUS (Marcus Vitruvius Pollio), in biography, a celebrated Roman architect, of whom however nothing is known, but what is to be collected from his ten books "De Architectura," still extant. In the preface to the sixth book, he writes, that he was carefully instructed in the whole circle of arts and sciences; a circumstance which he speaks of with much gratitude, laying it down as certain, that no man can be a complete architect without some knowledge and skill in every other branch of knowledge. And in the preface to the first book he informs us, that he was known to Julius Cæsar; that he was afterwards recommended by Octavia to her brother Augustus Cæsar; and that he was so favoured, and provided for, by this emperor, as to be out of all fear of poverty as long as he might live. It is supposed that Vitruvius was born either at Rome or Verona; but it is not known which. His books of architecture are addressed to Augustus Cæsar, and not only show consummate skill in that particular science, but also a very uncommon genius and natural abilities. Cardan ranks Vitruvius as one of the twelve persons, whom he supposes to have excelled all men in the force of genius and invention; and would not have scrupled to have given him the first place, if it could be imagined that he had delivered nothing but his own discoveries. Those twelve persons were, Euclid, Archimedes, Apollo-

nius Pergæus, Aristotle, Archytas of Tarentum, Vitruvius, Achindus, Mahomet Ibn Moses, the inventor or improver of algebra, Duns Scotus, John Suisset, surnamed the calculator, Galen, and Heber of Spain. The best edition of the architecture of Vitruvius is that of Amsterdam in 1649. Perrault gave an excellent French translation of the same, and added notes and figures: the first edition of which was published at Paris in 1673, and the second, much improved, in 1684. Mr. William Newton too, an ingenious architect, published in 1780, &c. curious commentaries on Vitruvius, illustrated with figures; to which is added a description, with figures, of the military machines used by the ancients.

VIVERRA, the *weasel*, in natural history, a genus of Mammalia, of the order Feræ. Generic character: six fore-teeth, rather sharp; tusks longer: tongue in some smooth, in others aculeated backwards; body of a lengthened form. Gmelin separates the Viverra from the Mustela genus, and includes the Lutræ, or otters, under the latter. Mr. Pennant unites the two first, and forms the Lutræ into a distinct genus. This arrangement appears preferable to the other, is adopted by Shaw, and will be followed here. There are forty-five species, of which the following are principally deserving of notice.

V. ichneumon, or the ichneumon, of which there are two varieties, the Indian and the Egyptian. The Egyptian ichneumon is nearly three feet and a half in full length, and of a pale reddish grey colour. It bears a mortal enmity to rats, and snakes, and other offensive animals, with which Egypt is infested, and is domesticated frequently in that country for the sake of its services on this account. With the ancient Egyptians it was not only in high estimation, but obtained the reputation of a sort of deity, and was thought entitled to a degree of adoration. Its movements are rapid and agile in the extreme. In approaching its prey it often moves upon its belly like the feline tribe, or rather in the manner of a serpent; at others it pursues it with rapid boundings. It is able to swim, and to dive also for a considerable time, and frequents chiefly the borders of rivers. The Indian ichneumon is considerably smaller, but is equally useful and esteemed. It attacks without terror, and even with the extreme of fierceness, the most formidable and venomous serpents, particularly the cobra de capello, and destroys them without difficulty. They are both formidable to animals much larger than themselves, fastening upon them with immoveable firmness, and sucking their blood till they are absolutely gorged with it.

V. striata, is a native of Mexico, and discriminated by five longitudinal stripes of white on its back of chocolate colour. When irritated by fear or anger it emits a vapour extremely fetid, in comparison with which every other odour, generally deemed repulsive and disgusting, is pronounced to be the most exquisite perfume. Even the dogs engaged in the pursuit of these creatures are stated to be compelled to abandon the course by this intolerable fetor, and if but a small drop of it should attach to the person or clothes of a human being, it is said to require the ablutions of several days to rid him of the nuisance, and prevent his being any longer avoided with disgust and horror.

V. civetta, or the civet, is a native of the warm territories of Asia and Africa, and above two feet long, exclusively of the tail. It subsists on smaller quadrupeds and birds. This animal is distinguished for its perfume, for which it was well known to the ancients, who considered it as one of the most powerful stimuli, and for which it is kept in a state of confinement in Holland at the present day, as well as in the East. The drug produced by the civets is formed in a glandular receptacle, and is taken from it by its keeper several times in the course of a week; the quantity generally procured from each civet at a time being about a drachm, but varying with the state of the animal's health, and the nourishing quality of its food. It is in its original state of a yellow colour and an unctuous appearance, and is extremely pungent, and indeed disagreeable. Every part of the animal is penetrated by its effluvia, and the effect of being shut up in a room with one of these creatures in a state of high irritation are nearly intolerable.

V. genetta, or the genet, is to be met with in Syria, Turkey, and Spain. These animals are about the size of a small cat, of a more lengthened form in head and body, and of a longer tail. They are distinguished by an agreeable perfume somewhat similar to musk. They are gentle, easily tamed, exceedingly active and cleanly, and in Constantinople and other places are frequently domesticated, and accomplish all the objects effected by the common cat. Their colour is a tawny-red, spotted with black.

V. foina, or the martin, is of a black

tawny colour, and about eighteen inches long. It is the most elegant of the weasel tribe, with a small head, elegant shape, and animated eyes, agile and graceful in its movements, capable of being reared, when taken young, to great familiarity and sportiveness, yet ever addicted to abandon the full supplies of confinement for the pleasures of freedom, however alloyed these may be by occasional indigence or destitution. It is an inhabitant of the woods, living upon small birds and other animals, and breeding in the holes of trees. It produces no disagreeable effluvia, but is strongly perfumed. Its fur is highly valued.

V. martes, or the pine martin, is distinguished from the former by its yellow breast. It is not frequent in England, but in Germany, Sweden, and North America, it is easily met with, particularly in woods of pine trees. Its fur is preferred considerably to that of the last. It confines itself to woods and fields, never entering the habitations of man, and breeds often in the nest of the squirrel, the buzzard, and the wood-pecker.

V. zibellina, or the sable, is about the same size as the martin. Its general colour is a deep shining brown, and the hair is ash-coloured at the roots, and black at the tips. It is found in the Arctic regions, and its fur is a most valuable article of commerce, when of a particular extent and beauty, being sold for from twelve to fifteen pounds. This extraordinary price for the skin of so small an animal induces the robust and hardy natives of the north to hunt sables amidst the rigours of winter with unwearied assiduity and perseverance. These make their progresses over regions covered with snow, and in the most intense severity of winter, marking the trees as they advance, that they may recognize their direction for return, and sometimes after spreading a net before the entrance of one of the burrows of a sable, waiting often even two whole days for the animal's appearance, and sometimes of course waiting in vain. These men, during the extreme hunger which they sometimes experience, find some allay to it by pressing on their stomachs with tightened cords thin pieces of board. The furs are most valued which are taken between November and February. The hunting in Siberia was formerly conducted by criminals banished to that country, and by soldiers sent to it for this particular business, and who were stationed there for several years, and both were obliged to furnish a certain number of skins. Sables are extremely active and lively by night, but spend the greater part of the day in sleep. They subsist on squirrels and small birds, which they pursue from one tree to another with the most elastic agility. Rats, pine tops, and fruits, are also eaten by them. They are stated also to be fond of fish, and to be capable both of diving and swimming. They live in holes in the banks of rivers, and under the roots of trees. See Mammalia, Plate XVI. fig. 5.

V. putorius, or the pole cat, bears a very striking resemblance to the martin, is possessed of extreme nimbleness and activity, and climbs trees, and even creeps up walls, with great rapidity. It devours the smaller animals without discrimination, and pigeons, poultry, and rabbits, experience from it most fatal havoc. During winter its necessities urge it to frequent, if possible, not only the barn, but also the dairy. It is stated, on respectable authority, that in some instances pole-cats have been observed to feed on fishes, particularly eels, which they have dragged from rivulets at a distance to their habitation, repeating their labours many times in the course of a single night, and consequently accumulating a great number of these fishes for their subsistence. This animal has been known in winter to attack bee-hives, and devour the honey. It is extremly fierce, and will defend itself with astonishing spirit, even against dogs. It is distinguished for the most disagreeable odour, which, however, is not retained in the skin long after the animal is killed, this being dressed with the fur on it, and being held in considerable estimation. The female produces, in summer, five or six young ones, which require the attentions of the parent only for a short time, and are trained to suck the blood of the animals procured by her for their support.

V. furor, or the ferret, resembles the pole-cat both in form and manners. It is a native of Africa, whence it is stated to have been imported into Spain for the destruction of the rabbits, which had multiplied in that country to the most injurious excess. It was thence introduced into other European countries, but is ill adapted to endure the rigours of a northern winter, being particularly susceptible of cold. It may be tamed, but appears little capable of gratitude or attachment, and has such a thirst for blood, that it has been known to grasp at the throats of infants in the cradle, and suck them till it has been completely gorg-

ed. It breeds twice a year, and will occasionally devour its young as soon as they are produced. In confinement it must be kept in a box provided with wool, or other warm materials, and may be fed with bread and milk. Its sleep is long and profound, and it awakes with a voracious appetite, which is most highly gratified by the blood of small and young animals. Its enmity to rats and rabbits is unspeakable, and when either are, though for the first time, presented to it, it seizes and bites them with the most phrensied madness. When employed to expel the rabbit from its burrows, it must be muzzled, as otherwise it will suck the blood of its victim, and instantly fall into a profound sleep, from which it will awake only to the work of destruction, committing in the warren, where it was introduced only for its services, the most dreadful waste and havoc. It is possessed of high irritability, and when particularly excited, is attended with an odour extremely offensive. See Mammalia, Plate XVI. fig. 4.

V. vulgaris, or the common weasel, is about nine inches long, including the tail, is elegant in its appearance, and light in its movements, but unpleasant by the odour which accompanies it. It dwells under the roots of trees, and subsists on field mice, small birds, and even young rabbits. It is also particularly fond of eggs. It is often fatal to the hare itself, which appears to entertain for the weasel extreme terror, and to be overwhelmed at the sight of it into a complete incapacity for resistance. It is a more formidable enemy to rats and mice than even the cat itself, as it has greater facility for pursuing them to their retreats, and on this account it is much valued and encouraged by the farmer. Its bite is said to be almost certainly, though not always immediately, fatal. Its teeth are extremely sharp, and generally first fixed on the head of its enemy, which often lingers in stupor, but scarcely ever regains soundness. It commences its depredations in the evening, and, when it has produced its young, ranges with extreme intrepidity and rapacity. It is frequent near corn-mills, and wherever rats and mice are abundant, and always retires with its prey to its burrow, instead of devouring it on the spot where it was killed, preferring it in a state of putrefaction. During confinement it appears highly agitated and restless, and has by many been supposed untameable, but Madamoiselle de Laistre has given an interesting and full detail of the manners of one which she undertook to protect and instruct, and which repaid her assiduity by the most sportive vivacity, the most harmless conduct, and even the most grateful attachment. For the stoat, see Mammalia, Plate XVI. fig. 3. Vol. iv.

VIVIANI (VINCENTIO), a celebrated Italian mathematician, was born at Florence in 1621, some say 1622. He was a disciple of the illustrious Galileo, and lived with him from the 17th to the 20th year of his age. After the death of his great master, he passed two or three years more in prosecuting geometrical studies without interruption, and in this time it was that he formed the design of his Restoration of Aristeus. This ancient geometrician, who was contemporary with Euclid, had composed five books of problems, "De Locis Solidis," the bare propositions of which were collected by Pappus, but the books are entirely lost, which Viviani undertook to restore by the force of his genius.

He broke this work off before it was finished, in order to apply himself to another of the same kind, which was, to restore the fifth book of Apollonius's "Conic Sections." While he was engaged in this, Borelli found, in the library of the Grand Duke of Tuscany, an Arabic M.S. with a Latin inscription, importing that it contained the eight books of Apollonius's Conic Sections, of which the eighth was not found to be there. He carried this M.S. to Rome, in order to translate it with the assistance of a professor of the oriental languages. So unwilling however was Viviani to lose the fruits of his labours, that he refused to receive the smallest account from Borelli on the subject. At length he finished the work, and published it in 1659, with the title "De Maximis et Minimis geometrica divinatio in quintum conicorum Apollonii Pergæi. He was called by the state to undertake an operation of great importance, viz. to prevent the inundations of the Tiber, in which Cassini and he were employed for some length of time. On account of his great talents he received a pension from Louis XIV. In 1666 he was honoured by the Grand Duke with the title of the first mathematician. He resolved three problems which had been proposed to all the mathematicians of Europe. In 16[illegible] he was chosen to fill, in the Royal Academy of Sciences, a place among the eight foreign associates. This circumstance, so honourable to his reputation, gave new vigour to his exertions, and he published three books

of the "Divination upon Aristeus," in 1701, which he dedicated to the King of France. Viviani acquired a good fortune, which he laid out in building a magnificent house at Florence; here he placed a bust of Galileo, with several inscriptions in honour of that great man. He died in 1703, aged 81.

VIVIPAROUS, in natural history, an epithet applied to such animals as bring forth their young alive and perfect, in contradistinction to them that lay eggs, which are called oviparous animals.

ULEX, in botany, *furze* or *gorse*, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: calyx two-leaved; legume scarcely longer than the calyx; filaments all connected. There are three species.

ULLAGE, in gauging, is so much of a cask, or other vessel, as it wants of being full. See GAUGING.

ULMUS, in botany, the *elm*, a genus of the Pentandria Digynia class and order. Natural order of Scabridæ. Amentaceæ, Jussieu. Essential character: calyx five-cleft, inferior, permanent; corolla none; capsule membranaceous, compressed, flat, one-seeded. There are seven species, two of which are natives of Britain, *viz.* the campestris, common elm; and the montana, or wych elm. All the sorts of elm may be either propagated by layers, or suckers, taken from the roots of the old trees, the latter of which is generally practised by the nursery gardeners. The elm delights in a stiff strong soil. It is observable, however, that here it grows comparatively slow. In light land, especially if it is rich, its growth is very rapid; but its wood is light, porous, and of little value, compared with that which grows upon strong land, which is of a closer, stronger texture, and at the heart will have the colour, and almost the heaviness and the hardness, of iron. On such soils the elm becomes profitable, and is one of the trees which ought, in preference to all others, to engage the planter's attention.

ULTRAMARINE. This precious colour, so remarkable for its beauty and durability, is a pure deep sky blue. It is capable of bearing a low red heat without injury, and it is not sensibly impaired by the action of the air and weather. It is the colouring matter of the mineral already described under the name LAZURSTEIN, and appears according to an analysis by Klaproth, to consist of little else than oxide of iron.

ULVA, in botany, a genus of the Cryptogamia Algæ class and order. Generic character: fructifications are small globules, dispersed through a pellucid membranaceous or gelatinous substance, or frond.

UMBELLIFEROUS *plants*, are such as have their tops branched and spread out like an umbrella; on each little subdivision of which there is growing a small flower; such are fennel, dill, &c.

UMBER. There are two kinds of umber, the one called Cologne umber, is a variety of peat or of earthy brown coal. There are large beds of it wrought in the neighbourhood of Cologne, principally as an article of fuel; a pretty considerable quantity is also imported into Holland, where it is used in the manufacture, or more properly in the adulteration of snuff, for which purpose it appears to be better than the common peat of the country; a still smaller quantity is consumed by the paintmakers. The colour of this vegetable umber is a warm somewhat pinkish brown, and is an useful ingredient to the painter in water-colours. The second kind of umber goes by the name of Turkish umber, and appears to be a variety of the iron ore called brown ironstone ochre. A specimen from Cyprus was analysed by Klaproth, and afforded him,

Oxide of iron	48
Oxide of manganese	20
Silex	13
Alumine	5
Water	14
	100

UNCARIA, in botany, a genus of the Pentandria Monogynia class and order. Essential character: corolla salver-shaped; germ crowned with a gland; stigma two-grooved; pericarpium two-celled, many-seeded. There are two species, *viz.* U. inermis, and U. aculeata.

UNCIA, in general, a Latin term denoting the twelfth part of any thing; particularly the twelfth part of a pound, called in English an ounce; or the twelfth part of a foot, called an inch.

UNCIÆ, in algebra, the numbers prefixed before the letters of the members of any power produced from a binomial, residual, or multinomial root. Thus, in the fourth power of $a + b$, *viz.* $a^4 + 4\,a^3\,b + 6\,a^2\,b^2 + 4\,a\,b^3 + b^4$, the unciæ are 4, 6, 4; being the same with what others call coefficients. See BINOMIAL, ALGEBRA, &c.

UNDECAGON, in geometry, is a polygon of eleven sides. If the side of a regular undecagon be 1, its area will be 9.36564 nearly $= \frac{11}{4} \times$ tang. of $73\frac{7}{11}$ degrees; and therefore if this number be multiplied by the square of the side of any other regular undecagon, the product will be the area of that undecagon.

UNDER *currents*, currents distinct from the upper or apparent currents of the seas. Some naturalists conclude that there are in divers places under currents which set or drive a contrary way from the upper current, whence they solve the remarkable phenomena of the sea's setting strongly through the Streights into the Mediterranean, with a constant current twenty leagues broad; as also, that running from the Euxine through the Bosphorus into the Hellespont, and thence into the Archipelago; they conjecture, that there is an under current whereby as great a quantity of water is carried out as comes in. To confirm this, it is observed, that between the North and South Foreland, it is either high or low water upon the shore three hours before it is so off at sea; a certain sign, that though the tide of flood runs aloft, yet the tide of ebb runs under foot, or close by the ground. Yet Dr. Halley solves the currents setting in at the Streights without overflowing the banks, from the great evaporation, without supposing any under current.

UNDERSTANDING or JUDGMENT, in the Hartleyan acceptation of the term, is that faculty by which we contemplate mere sensations and ideas, pursue truth, and assent to, or dissent from, propositions. In this article, and in WORDS, we shall, as we proposed in PHILOSOPHY, *mental*, § 104, lay before our readers a view of the highly important principles of Hartley respecting the understanding, occasionally making in his statements such alterations as will best adapt them to our object.

Whatever be the precise nature of assent and dissent, they must class with ideas, being only those very complex internal feelings which are connected by association with those groups of words which are called propositions in general, or affirmations and negations in particular.—Assent (and consequently its opposite, dissent) may be distinguished into two kinds, rational and practical. Rational assent to any proposition may be defined a readiness to affirm it to be true, proceeding from a close association of the ideas suggested by the proposition, with the idea or internal feeling belonging to the word truth; or of the terms of the proposition with the word truth. Rational dissent is the opposite to this.—Practical assent is a readiness to act in such a manner as the frequent vivid recurrency of the rational assent disposes us to act; and practical dissent the contrary.

Practical assent is then the natural consequence of rational assent, when sufficiently impressed. It must however be observed, first, that some propositions, mathematical ones for instance, admit only of a rational assent, the practical not being applied to them in common cases: secondly, that the practical assent is sometimes generated, and arrives at a high degree of strength, without any previous rational assent, and by methods which have little or no connection with it; yet still is in general much influenced by it, and, conversely, exerts a great influence upon it: thirdly, practical assent may be in opposition to rational assent, and in consequence of its having been long and firmly cultivated, may altogether prevent the latter from influencing the conduct.

Let us next inquire into the causes of rational and practical assent, beginning, I. with that given to mathematical conclusions.—Now the original cause that a person affirms the truth of the proposition, twice two are four, is the entire coincidence of the visible or tangible idea of twice two, with that of four, as impressed upon the mind by various objects. We see every where that both are only different names for the same impression; and it can only be in consequence of association that the word truth, its definition, or internal feeling, becomes appropriated to this coincidence.—Where the numbers are so large that we cannot form any distinct visible ideas of them, as when we say 12 times 12 are equal to 144, rational assent is founded (if not on the authority of a table or a teacher) on a coincidence of words arising from some method of reckoning up 12 times 12, so as to conclude with 144, and resembling the coincidence of words which attends the before-mentioned coincidence of ideas in the simpler numerical propositions.—The operations of addition, subtraction, multiplication, division, and extraction of roots, with all the most complex operations relating to algebraic quantities considered as the denotements of numbers, are no more than methods of producing this coincidence of

words, founded upon and rising above one another. And it is merely association again which appropriates the word truth, &c. to the coincidence of the words or symbols which denote the numbers.

This coincidence of terms is considered as a proof that the visible ideas of the numbers under consideration would coincide as much as the visible ideas of twice two and four, were the former equally distinct with the latter; and indeed the same thing may be fully proved, and often is so, by experiments with counters, lines, &c. And hence thinking persons, who make a distinction often unthought of, between the coincidence of terms and that of ideas, consider the real and absolute truth to be as great in complex numerical propositions as in the simplest. Now as it is impossible to gain distinct visible ideas of different numbers, where at least they are considerable, terms denoting them are a necessary means of distinguishing them one from another, so as to reason justly respecting them.

In geometry there is a like coincidence of lines, angles, spaces, and solid contents, to prove them equal in simple cases. Afterwards, in complex cases, we substitute the terms whereby equal things are denoted for each other, and then the coincidence of the terms to denote the coincidence of the visible ideas, except in the new step advanced in the proposition, and thus we get a new equality, denoted by a new coincidence of terms, and this in like manner we employ in order to obtain a new equality. This resembles the addition of unity to any number in order to make the next, as of 1 to 20 in order to make 21. We have no distinct visible idea of 20 or of 21; but we have of the difference between them, by fancying to ourselves a confused heap of things, supposed or called twenty in number, and then further fancying one thing to be added to it. By a like process in geometry we arrive at the demonstration of the most complex propositions.—The properties of numbers are applied to geometry in many cases, as when we demonstrate a line or space to be half or double of any other, or in any other ratio to it.—And as in arithmetic words stand for indistinct ideas, in order to help us to reason about them as accurately as if they were distinct; as also cyphers stand for words, for the same purpose, and letters for cyphers, to render the conclusions less particular, so letters are put for geometrical quantities also, and the agreements of the letters for those of the quantities.

Thus we see the foundation upon which the whole doctrine of quantity is built; for all quantity is denoted either by numbers, or by extension, or by letters denoting either one or the other. The coincidence of ideas is the foundation of rational assent in simple cases, and that of ideas and of terms, or of terms alone, in complex cases. This is upon the supposition that the quantities are to be proved equal, but if they are to be proved unequal, the want of coincidence answers the same purpose. If they are in any numerical ratio, this is only introducing a new coincidence.—Thus it appears that the use of words, (either as visible or as audible symbols), is necessary for geometrical and algebraic reasonings, as well as for arithmetical. Also that association prevails in every part of the processes hitherto described.

But these are not the only causes of giving rational assent to mathematical propositions. The recollection of having once examined and assented to each step of a demonstration, the authority of an approved writer, &c. are often sufficient to gain our assent, though we understand no more than the import of the proposition, nay, even though we do not proceed so far as this. Now this again is a mere transfer of association; the recollection, authority, &c. being in a great number of cases associated with the before-mentioned coincidence of ideas and terms.—But here a new circumstance arises, for memory and authority are sometimes found to mislead; and the recollection of such experience puts the mind into a state of doubt, so that sometimes truth, sometimes falsehood, will recur and unite itself with the proposition under consideration, according as the recollection, authority, &c. in all their peculiar circumstances have been associated with truth or with falsehood.

Thus the idea belonging to a mathematical proposition, with the rational assent or dissent arising in the mind, as soon as it is presented to it, is nothing more than a group of ideas united by association, and forming a very complex idea (§ 53.) And this idea is not merely the sum of the ideas belonging to the terms of the proposition, but also includes the notions or feelings, whatever they be, which belong to the words equality, coincidence, and truth, and, in some cases those of utility, importance, &c.—For

mathematical propositions are, in some cases, attended with a practical assent, in the proper sense of these words as when a person takes this or that method of executing a projected design, in consequence of some mathematical proposition assented to from his own examination, or from the authority of others. Now the train of voluntary actions denoting the practical assent, is produced by the frequent recurrency of ideas of utility and importance. These operate by association, and though the rational assent be a previous requisite, yet the degree of the practical assent is proportional to the vividness of those ideas; and in most cases they strengthen the rational assent by reaction.

II. Propositions concerning natural bodies are of two kinds, vulgar and scientifical. Of the first kind are, "milk is white," "gold is yellow," "a dog barks," &c. These are evidently nothing more than forming the terms denoting the whole or some component parts of the complex idea, into a proposition, or employing those denoting some of its common adjuncts in the same way. The assent given to such propositions arises from the associations of the terms as well as of the ideas denoted by them.

In scientifical propositions concerning natural bodies, a definition having been made of the body from its properties, another property or power is joined to them as a constant or common associate. Thus gold is said to be soluble in the nitro-muriatic acid. Now to persons who have made the proper experiments a sufficient number of times, these words suggest the ideas which occur in those experiments, and conversely are suggested by them, in the same manner as the vulgar propositions above mentioned suggest, and are suggested by common appearances. But then, if they be scientific persons, their readiness to affirm that gold is soluble in this acid universally, arises also from the experiments of others, and from their own and other persons' observations on the constancy and tenor of nature. They find it to be a general truth, that almost any two or three remarkable qualities of a natural body, infer the rest, being never found without them, and hence arises a readiness to affirm respecting all bodies possessing those two or three leading qualities, whatever may be affirmed of one.

The propositions formed respecting natural bodies are often attended with a high degree of practical assent, arising chiefly from some supposed utility and importance, and which is no ways proportioned to the foregoing or similar acknowledged causes of rational assent. And in some cases the practical assent takes place before the rational, but then, after some time, the rational assent is generated and cemented most firmly by the prevalence of the practical. This process is particularly observable in the regards paid to medicines; that is, in the rational and practical assent to the propositions concerning their virtues.

The influence of the practical assent over the rational, arises from their being united in so many cases. And the vividness of the ideas arising from the supposed utility, importance, &c. produce a more ready and closer union of the terms of the proposition.

III. The evidences for past facts are a man's own memory, and the authority of others. These are under proper restrictions, the usual associates of true past facts, and therefore produce the readiness to affirm a past fact to be true, that is, the rational assent. The integrity and competency of the witnesses being the principal restriction or requisite in the accounts of past facts, become principal associates to the assent to them, and the contrary qualities to dissent.

If it be asked 'how a narration of an event supposed to be certainly true, or to be doubtful, or to be entirely fictitious, differs in its effect upon the mind in these circumstances respectively, the words in which it is narrated being the same in case?' it may be replied, first, in having the terms true, doubtful, or fictitious, with a variety of ideas usually associated with them, and the corresponding internal feelings of respect, anxiety, dislike, &c. connected with them respectively, whence the whole effects, exerted by each upon the mind, will differ considerably from one another. Secondly, if the events be of a very interesting nature, the related ideas will recur oftener, and thus agitate the mind the more, in proportion to the supposed truth of the event. And it confirms this, that the frequent recurrence to the mind of an interesting event, supposed to be doubtful, or even fictitious, by degrees makes it appear like a real one. The practical assent to past facts often produces the rational assent, as in the other cases before spoken of.

IV. The evidence for future facts is of the same kind with that for the propositions concerning natural bodies, being like it ta-

ken from induction and analogy. This is the foundation of the rational assent. The practical depends upon the recurrency of the ideas, and the degree of agitation produced by them in the mind. Hence reflection makes the practical assent grow for a long time after the rational is arisen to its height; or, which is often the case, if the practical assent arises in any considerable degree, without the rational, it will generate the rational. Thus the sanguine are apt to believe and assert what they hope to be true; and the timorous what they fear.

V. There are many speculative abstract propositions in logic, metaphysics, ethics, controversial divinity, &c. the evidence for which is the coincidence or analogy of the abstract terms, in certain particular applications of them, or as considered in their grammatical relations. This causes the rational assent. As to the practical assent or dissent, it arises from the ideas of importance, reverence, piety, duty, ambition, jealousy, envy, self-interest, &c. which intermix in these subjects, and thus, in some cases, add great strength to the rational assent, in others destroy it, and convert it into its opposite.

On the whole it appears that rational assent has different causes in propositions of different kinds, and practical assent in like manner: that the causes of rational are also different from those of practical: that there is, however, a great affinity and general resemblance in all the causes; that rational and practical assent exert a perpetual reciprocal influence on each other: and, consequently that the ideas belonging to assent and dissent, and their equivalents and relatives are highly complex, unless in the cases of very simple propositions, such as mathematical ones. For, besides the coincidence of ideas and terms, they include, in other cases, ideas of utility, importance, respect, disrespect, ridicule, religious affections, hope, fear, &c. and bear some gross general proportion to the vividness of these ideas.

It follows from the preceding statements, that vicious men, that is, all persons who want practical faith, must be prejudiced against the historical and other foundations for rational faith in revealed religion. Further, it is impossible any person should be so sceptical as not to have the complex ideas denoted by the words assent and dissent associated with a great variety of propositions in the same manner as in other persons; just as he must have the same ideas in general affixed to the words of his native language, as other men have. An universal sceptic is therefore no more than a person who varies from the common usage in his application of a certain set of words, viz. truth, certainty, assent, dissent, &c.

We shall close this article with the very important remarks on evidence, given by Hartley, in proposition 87; referring to the original those readers who wish to see how he illustrates or proves them by the employment of simple mathematical expressions, and who are disposed to enter into his important observations respecting the ascertainment of truth and the advancement of knowledge.

1. If the evidences for any proposition, fact, &c. be dependant on each other, so that the first is required to support the second, the second the third, and so on; that is, if a failure of any one of the evidences renders all the rest of no value, the separate probability of each evidence must be very great in order to make the proposition credible; and this holds so much the more, as the dependent evidences are more numerous.

2. If the evidences for any proposition, fact, &c. be independent on each other; that is, if they be not necessary to support each other, but concur, and can, each of them, when established upon its own proper evidences, be applied directly to establish the proposition, fact, &c. in question; the deficiency in the probability of each must be very great, in order to render the proposition perceptibly doubtful, and this holds so much the more, as the evidences are more numerous.

3. The resulting probability may be sufficiently strong in dependent evidences, and of little value in independent ones, according as the separate probability of each evidence is greater or less. Thus the principal facts of ancient history are not less probable practically now, than ten or fifteen centuries ago; nor less so then, than in the times immediately succeeding, because the diminution of evidence in each century is imperceptible. And for the same reason a large number of weak arguments prove little.

4. It appears likewise, that the inequality of the separate evidences does not produce much alteration in these remarks. In like manner, if the number of evidences, dependent or independent, be great, we may make great concessions as to the value of each. Again, a strong evidence in de-

pendent ones can add nothing, but must weaken a little; and after a point is well settled by a number of independent ones, all that come afterwards are in one sense useless, because they do no more than remove the imperceptible remaining deficiency; on the other hand, however, as evidence produces different effects on different minds, it is of great moment in all points of general importance, to have as many satisfactory independent evidences as possible brought into view, that if one fail in its effects, from peculiar circumstances, another may supply its place. And it will be of great use to pursue these and such like deductions, both mathematically, and by applying them to proper instances selected from the sciences, and from common life, in order to remove certain prejudices, which the use of general terms and ways of speaking, with the various associations with them, is apt to introduce and fix upon the mind. It cannot but assist us, in the art of reasoning, thus to analyse, recompose, and ascertain our evidences.

UNDULATION, in physics, a kind of tremulous motion or vibration observable in a liquid, whereby it alternately rises and falls like the waves of the sea. This undulatory motion, if the liquid be smooth and at rest, is propagated in concentric circles, as most people have observed upon throwing a stone, or other matter, upon the surface of a stagnant water, or even upon touching the surface of the water lightly with the finger, or the like. The reason of these circular undulations is, that by touching the surface with your finger, there is produced a depression of the water in the place of contact. By this depression, the subjacent parts are moved successively out of their place, and the other adjacent parts thrust upwards, which lying successively on the descending liquid, follow it; and thus the parts of the liquid are alternately raised and depressed, and that circularly. When a stone is thrown into the liquid, the reciprocal vibrations are more conspicuous: here the water, in the place of immersion, rising higher by means of the impulse, or rebound, till it comes to fall again, gives an impulse to the adjoining liquid, by which means that is likewise raised about the place of the stone as about a centre, and forms the first undulous circle; this falling again, gives another impulse to the fluid next to it, further from the centre, which rises likewise in a circle; and thus successively greater and greater circles are produced.

UNGULA, in geometry, the section of a cylinder cut off by a plane passing obliquely through the plane of the base and part of the cylindric surface.

UNICORN, an animal famous among the ancients, but looked upon by the moderns as fabulous, denominated from its distinguishing characteristic of having one horn only, which is represented as five palms long, and growing in the middle of the forehead.

The unicorn is one of the supporters of the British arms. It is represented, by heralds, passant, and sometimes rampant. When in this last action, as in the British arms, it is properly said to be saillant. Argent, an unicorn sejant sable, armed and unguled, or, borne by the name of harding.

UNICORN *fish*. See MONODON.

UNIOLA, in botany, a genus of the Triandria Digynia class and order. Natural order of Gramina. Gramineæ, Jussieu. Essential character: calyx many valved; spikelet ovate, keeled. There are three species.

UNONA, in botany, a genus of the Polyandria Polygynia class and order. Natural order of Coadunatæ. Anonæ, Jussieu. Essential character: calyx three-leaved; petals six; berries two or three-seeded, jointed like a necklace. There are four species.

UNISON, in music, the effect of two sounds which are equal in degree of tune, or in point of gravity and acuteness.

UNITARIANS, in church history, are those who believe that there is but one God, the supreme object of religious worship; and that this God is the Father only, and not a Trinity consisting of Father, Son, and Holy Ghost.

The Unitarians having been frequently confounded with the old Socinians, it is but justice to observe, that a very material difference exists in some parts of the religious faith of these two sects. The Socinians believed that Jesus Christ, though a human being, was advanced by God to the government of the whole created universe, and was, therefore, the proper object of religious worship. On account of their essential deviation from the doctrine of Socinus, in this and some other respects, the modern Unitarians disclaim the appellation Socinian as inapplicable to their views of religious faith and worship. This term is, however, very comprehensive, and is applicable to a great

variety of persons, who, notwithstanding, agree in this one common principle, that there is no distinction in the divine nature.

The appellation of Unitarian may be considered as a generic term, including in it a number of specific differences. Indeed, all those who reject the doctrine of the Trinity, and pay divine worship to the Father only, may with propriety be called Unitarians. As it is a principle among this body of Christians, that the most unbounded liberty ought to be granted to every individual to understand and explain the doctrines of the Scriptures according to his own particular views, it has long been divided into a number of parties, differing on various subjects not immediately affecting the leading doctrine of the Divine Unity. Though the ancient Arians appear never to have adopted this appellation, yet most of their successors of the present day assert that they have a just claim to the title; because, they say, that they pay divine adoration to the one God and Father only, and not to Jesus Christ, or to the Holy Ghost. If this be admitted, it will appear that the Unitarian doctrine is of very ancient date. Indeed, they profess to derive their faith solely from the sacred Scriptures of the Old and New Testaments.

Soon after the Nicene Council, when the Christian world had wearied itself with religious wars and disputes concerning doctrines and government; and the Papal power had, apparently, converted the kingdom of Christ into a kingdom of this world, the subjects of religious controversy ceased, in a great degree, to agitate the minds of men, until the memorable period of the Reformation. Then again did the flame, which had been long smothering, burst out; and the great and leading maxim, of the right of private judgment in matters of religion, on which the Reformation was founded, once more gave liberty to the powers of the human understanding. How far those powers were exerted against many of the doctrines of the Church of Rome, we have already described in the articles PROTESTANTS and REFORMATION. Though Luther and his adherents, had done much towards effecting a complete reformation in religion, it was thought by many persons of great learning and piety, that much still remained to be cleared away, before the religion of Jesus Christ could again assume its native lustre and purity. Among the number of those who were of this opinion, was a learned and eminent physician of Spain, commonly called Michael Servetus. This gentleman, conceiving that the ideas generally maintained, concerning the Trinity, and some other popular doctrines, were false and dangerous, discovered and propagated what he conceived to be a more rational theory; the leading feature of which related to the doctrine of the Trinity, which he flatly denied; at least in the manner in which it was then commonly understood.

On this subject he published his famous book, entitled "De Trinitatis Erroribus;" with which, as Oecolampadius, writing to Bucer, observes, the reformers at Berne were very much offended. At the same time he remarks, that the churches would be very ill spoken of, unless their divines would make it their business to "cry it down." "We know not," he continues, "how that beast, (Servetus) came to creep in among us; he wrests all passages of Scripture to prove, that the Son is not co-eternal and consubstantial with the Father, and that the man Christ is the Son of God."

Now it was, that the fears of Melancthon began to be realized. In a letter to Joachim Cameraper, this reformer thus expresses himself: "You know that I was always afraid, that these disputes about the Trinity would break out some time or other. Good God! what tragedies will this question produce among posterity;—whether the Logos be a substance or a person." To alleviate, in some measure, these fears, this meek reformer wrote a letter to the Popish Senate at Venice, beseeching them to use their utmost endeavours to prevent the spread of the errors contained in Servetus's book. It was, however, reserved for the zeal of Calvin to convince the religious world that the reformers, with all their zeal against popery, had not learned to shake off a spirit of fiery persecution against those whom they chose to account heretics. Not content with calling Servetus "the proudest knave of the Spanish nation," "a villainous, obscene, barking dog, a blockhead and a beast," this furious bigot, with all the abominable cant with which the genius of his religious creed could amply supply him, caused the unhappy Servetus to be burnt at the stake as a heretic, after having harassed and tormented him in every possible way that the most determined villainy and artful hypocrisy could suggest. Thus died the first Unitarian martyr after the Reformation; and thus was he treated by one of the principal reformers!

It was probably from the books of

Michael Servetus that Lælius Socinus, and many other Italians, first imbibed their anti-trinitarian opinions. From the papers of Lælius Socinus, his nephew, Faustus Socinus, was afterwards led to the study of theology. He improved on the system of his uncle; and was the cause of the Unitarian doctrine spreading itself over a great part of Europe. In Poland, in particular, this sect made astonishing progress. By them was published the famous Racovian Catechism; and the writings of the Polones Fratres, in six large folio volumes, entitled, "Bibliotheca Fratrum," are replete with learning, and great biblical knowledge. The leading doctrines maintained by the Polonian brethren, are as follow:

That the Holy Scriptures are to be understood and explained in such a manner as that their doctrines shall be strictly agreeable to the true principles of reason.

In consequence of this leading point in their theology, they maintained that God, who is infinitely more perfect than man, though of a similar nature in some respects, exerted an act of that power by which he governs all things; in consequence of which, an extraordinary person was born of the Virgin Mary. That person was Jesus Christ, whom God first translated to heaven by that portion of his divine power called the Holy Ghost. Socinus and some of his followers entertained this notion of Christ's having been, in some unknown time of his life, taken up personally into heaven, and sent down again to the earth, by which they solved these expressions concerning him: "No man has ascended to heaven but he that came down from heaven, even the Son of Man which is in heaven." (John iii. 13.) Thus Moses, who was the type of Christ, before the promulgation of the law, ascended to God upon Mount Sinai. So Christ, before he entered on the office assigned him by the Father, was in consequence of the divine counsel and agency, translated into heaven, that he might see the things he had to announce to the world in the name of God himself. Being thus fully instructed in the knowledge of his counsels and designs, he sent him again into this sublunary world to promulgate to mankind a new rule of life, more excellent than that under which they had formerly lived, to propagate divine truth by his ministry, and to confirm it by his death.

That those who obey the voice of this divine teacher (and this obedience is in the power of every one whose will and inclination leads that way) shall one day be clothed with new bodies, and inhabit eternally those blessed regions where God himself immediately resides. Such, on the contrary, as are disobedient and rebellious shall undergo most terrible and exquisite torments, which shall be succeeded by annihilation, or the total extinction of their being.

Faustus Socinus supposed that, in condescension to human weakness, in order that mankind might have one of their own brethren more upon a level with them, to whom they might have recourse in their straits and necessities, Almighty God, for his eminent virtues, had conferred upon Jesus Christ, the Son of Mary, some years after he was born, a high divine power, lordship, and dominion, for the government of the christian world only; and had qualified him to hear and answer the prayers of his followers in such matters as related to the cause of the gospel. The chief foundation on which Socinus founded the opinion of Christ's being an object of religious worship, was the declarations in the scriptures concerning the kingdom and power bestowed upon him. The interpretation which he put on those passages which speak of angels and heavenly powers being put under him, and worshipping him; his having a knowledge of the secret thoughts of men imparted to him, and the like, which, with some presumed instances of the fact, of prayer being actually made to him, he maintained to be a sufficient though indirect signification of the divine will, that men should invoke Christ by prayer. But he constantly acknowledged that there was no express precept for making him an object of religious worship.

Socinus allowed that the title of true God might be given to Christ; though all he meant by it was, that he had a real divine power and dominion bestowed upon him, to qualify him to take care of the concerns of christians, and to hear and answer their prayers, though he was originally nothing more than a human creature.

There were some among the early Socinians who disapproved and rejected the worship paid to Christ, as being without any foundation in the Holy Scriptures, the only rule of christian faith and worship.

This is a general outline of the doctrines of the Socinians.

The Unitarians, of the present day, are principally divided into Arians and Huma-

nitarians, or believers in the simple humanity of Christ. For an account of the first of these two classes, see the article ARIANS. The summary of doctrines held by modern Unitarians is as follows: The capital article in the religious system of this denomination is, that Christ was a mere man. But they consider him as the great instrument in the hands of God of reversing all the effects of the fall as the object of all the prophecies from Moses to his own time, as the great bond of union to virtuous and good men, who, as christians, make one body in a peculiar sense, as having communications with God, and speaking and acting from God in such a manner as no other man ever did, and therefore, havingthe form of God, and being the Son of God in a manner peculiar to himself; as the mean of spreading divine and saving knowledge to all the world of mankind, as, under God, the head of all things to his church; and as the Lord of life, having power and authority from God to raise the dead, and judge the world at the last day. They suppose that the great object of the whole scheme of revelation was to teach men how to live here so as to be happy hereafter, and that the particular doctrines they taught, as having a connection with this great object, are those of the unity of God, his universal presence and inspection, his placability to repenting sinners, and the certainty of a life of retribution after death. They suppose, that to be a christian implies nothing more than the belief that Christ and his apostles, as well as all preceding prophets, were commissioned by God to teach what they declare they received from him; the most important article of which is the doctrine of a resurrection to immortal life.

This denomination of Christians argue against the divinity and pre-existence of Christ in the following manner: the scriptures contain the clearest and most exprses declarations that there is but one God, without ever mentioning any exception in favour of a Trinity, or guarding us against being led into any mistake by such general and unlimited expressions. Exod. xx. 3. "Thou shalt have no other God but me." Deut. vi. 4. Mark xii. 29. 1 Cor. viii. 6. Ephes. iv. 5. It is the uniform language of the sacred books of the Old Testament, that one God, without any assistant either equal or subordinate to himself, made the world and all things in it, and that this one God continues to direct all the affairs of men. The first book of Moses begins with reciting all the visible parts of the universe as the work and appointment of God. In the ancient prophetic accounts, which preceded the birth of Christ, he is spoken of as a man, as a human creature highly favoured of God, and gifted with extraordinary powers from him, and nothing more. He was foretold, Gen. xxii. 8, to be of "the seed of Abraham." Deut. xviii. "A prophet like unto Moses." Psal. cxxxii. 11: "Of the family of David," &c. As a man, as a prophet, though of the highest order, the Jews constantly and uniformly looked for their Messiah. Christ never claimed any honour nor respect on his own account, nor as due to himself as a person only inferior to the most high God, but such as belonged only to a prophet, an extraordinary messenger of God, to listen to the message and truths which he delivered from him. He in the most decisive terms declares the Lord God to be one person; and simply, exclusive of all others, to be the sole object of worship. He always prayed to the one God as his God and Father. He always spoke of himself as receiving his doctrine and power from him, and again and again disclaimed having any power of his own. John v. 19: "Then answered Jesus, and said unto them, verily, verily, I say unto you, the Son can do nothing of himself." John xiv. 10: "The words which I speak unto you, I speak not of myself, but the Father that dwelleth in me, he doeth the works." He directed men to worship the Father; and never let fall the least intimation that himself or any other person whomsoever was the object of worship. (See Luke xi. 1, 2. Matt. ix. 10.) He says in John xvi. 23, "And in that day ye shall ask me nothing. Verily, verily, I say unto you, whatsoever ye shall ask the Father in my name, he will give it you."

Christ, they say, cannot be that God to whom prayer is to be offered, because he is the high priest of that God to make intercession for us. (Acts vii. 25.) And if Christ be not the object of prayer, he cannot be either God or the maker and governor of the world under God. The apostles, to the latest period of their writings, speak the same language, representing the Father as the only true God, and Christ as a man, the servant of God, who raised him from the dead, and gave him all the power of which he is possessed, as a reward for his obedience. In Acts ii. 22, the apostle Peter calls Christ "a man approved of God,"

&c.; and in Acts xvii. the apostle calls him "the man whom God has ordained." 1 Tim. ii. 5. "There is one God, and one Mediator between God and man, the man Christ Jesus." Had the apostle Paul considered Christ as being any thing more than a man with respect to his nature, he could never have argued with the least propriety or effect, "that as by man came death, so by man came also the resurrection of the dead:" for it might have been replied, that by man came death, but not by man, but by God, or the Creator of the world under God, came the resurrection from the dead. The apostles directed men to pray to God the Father only: Acts iv. 24. Rom. xvi. 27, &c.

This denomination maintain that repentance and a good life are of themselves sufficient to recommend us to the divine favour; and that nothing is necessary to make us in all situations the objects of his favour, but such moral conduct as he has made us capable of. That Christ did nothing by his death or in any other way to render God kind and merciful to sinners; or rather that God is of his own accord disposed to forgive men their sins, without any other condition than the sinner's repentance, is declared by the Almighty himself constantly and expressly in the Old Testament, and never contradicted in the New. Isaiah lv. 7. "Let the wicked forsake his way, and the unrighteous man his thoughts, and let him return unto the Lord, and he will have mercy upon him, and to our God, for he will abundantly pardon." See also Ezek. xviii. 27. This most important doctrine of the efficacy of repentance alone on the part of the sinner, as sufficient to recommend him to pardon with God, is confirmed by Christ himself, Matt. vi. 12. "If ye forgive men their trespasses, your heavenly Father will also forgive you." But above all, the beautiful and affecting parable of the prodigal son, (Luke xv.) is most decisive that repentance is all our heavenly Father requires to restore us to his favour.

The Unitarians of all ages have adopted sentiments similar to those of Pelagius, with respect to human nature.

Of late years, the Unitarians have been very much upon the increase. They have several societies, in various parts of the country, for the promotion of their principles by the publication of books. In London they have two large and flourishing public societies.—The one called "The Unitarian Society for promoting Christian Knowledge and the practice of Virtue, by the distribution of books." This society has lately published "An improved version of the New Testament, upon the basis of Archbishop Newcome's new translation, with a corrected text, and notes critical and explanatory." Among the members of this society are to be found some men of high literary and political character. The other society, established in London, is called the "Unitarian Fund, for promoting Unitarianism by means of popular preaching." The objects of which are stated to be: "1. To enable poor Unitarian congregations to carry on religious worship. 2. To reimburse the travelling and other expenses of teachers who may contribute their labours to the preaching of the gospel on Unitarian principles; and 3. To relieve those Christian ministers who by embracing Unitarianism subject themselves to poverty." This society has now several missionaries in various parts of the united kingdom, and its funds are said to be in a flourishing state.

This denomination is now spreading itself in America. There are also some societies in France, and other parts of the Continent, of Unitarian Christians.

UNITY, in poetry. In the drama there are three unities to be observed, viz. the unity of action, that of time, and that of place. In the epic poem, the great, and almost only unity, is that of the action. Some regard, indeed, ought to be had to that of time, that of place there is no room for. The unity of character is not reckoned among the unities. The unity of the dramatic action consists of the unity of the intrigue in comedy, and that of the danger in tragedy, and this not only in the plan of the fable, but also in the fable extended and filled with episodes.

UNIVALVE *shells*, in natural history, a term used to express one of the three general classes of shell fish, the other two being the Bivalves and Multivalves. See CONCHOLOGY, SHELLS, &c.

UNIVERSALISTS, in church history, were originally those reformers who taught a kind of middle doctrine, between the systems of Calvin and Arminius. They were denominated hypothetical Universalists, because they maintained, that God is willing to show mercy to all mankind, and because they held, that faith in Christ is a necessary condition, to render them the objects of the divine mercy. These opinions were intended to be opposed to the harsh and cruel notions of Calvin, concern

[illegible]nitarians, or believers in the simple huma[illegible] of Christ. For an account of [illegible] these two classes, see the [illegible] The summary of doctr[illegible] Unitarians is as follo[illegible] cle in the religious [illegible] tion is, that Christ [illegible] they consider [illegible] in the hands of [illegible] fects of the [illegible] prophecies [illegible] the great [illegible] good [illegible] body [illegible] [illegible] of all [illegible] [illegible]cluded by [illegible] benefits that [illegible] sufferings, and [illegible] can be made a par[illegible] [illegible] of the Gospel, and of [illegible] unless he believe in Jesus [illegible]

[illegible] indeed, is the immense and [illegible] goodness of the Supreme Being, [illegible] to none the power of believ[illegible] [illegible] he does not grant unto all his [illegible] and succour, that they may wise[illegible] [illegible] this power to the attainment of [illegible] salvation:

[illegible] that, in consequence of this, multi[illegible] perish through their own fault, and not from any want of goodness in God.

It does not, indeed, appear, how this mitigated view of the doctrine of predestination can effectually destroy the heart-appalling thoughts occasioned by the more open and direct notions of Calvin and his adherents; but such were the opinions taught by the hypothetical Universalists; and they were not without their good effect, in softening down many of the rigours of high Calvinism. But the term Universalists has now obtained a far more extensive signification; as it is used to designate those Christians, who hold the doctrine of the future restoration of all men to eternal life and happiness. This sentiment was embraced by Origen in the third century; and, in more modern times, by the Chevalier Ramsay, Dr. Cheyne, Dr. Hartley, and others. The most popular advocates for this doctrine, were Dr. Chauncy and the late Rev. Elhanan Winchester.

Dr. Chauncy held, that as Christ died, not for a select number of men only, but for all men universally, that therefore all men shall finally partake of the benefits of his death; if not in this state of existence, yet in another. He held, that, as a mean, in order to man's being meet for salvation, God will, sooner or later, bring them all to [illegible] [illegible]dient subjection to his mo[illegible] [illegible].

[illegible] [illegible]trine is maintained by many, not [illegible] as they say, because it appears to [illegible] [illegible]icated by some passages of Scrip[illegible] [illegible], but because it is strictly agreeable to [illegible] spirit and genius of the dispensation of universal goodness displayed in the Gospel of Christ. They contend, that the doctrine of eternal punishments is not only a cruel and hateful doctrine, but subversive of all proper ideas of the benevolent and wise character of the Almighty, as well as destructive of the true use and design of all punishment. And as punishment cannot proceed from a vindictive spirit on the part of the Almighty, it must be designed so to correct the offenders against his moral laws, as to destroy the necessity of eternal punishment, and restore the sinner to obedience, and a desire after reformation; which reformation, when effected, must render all further punishment both unmerciful and unjust. In defence of this reasoning they say, that the scriptural words rendered *everlasting*, *eternal*, *for ever*, and *for ever and for ever*, are frequently used to express things of limited duration; and that, when they refer to the future state of punishment, they are always to be so understood; because to interpret these words otherwise, would be to reason contrary to the analogy of faith, the ideas of the divine goodness, the design of the Gospel, and the plain dictates of right reason. This doctrine has to boast of having, among its advocates and defenders, the names of Origen and his disciples; of many of the German Baptists prior to the reformation; and, in later times, of Petitpiere, a learned Swiss; of Dr. Rust, Bishop of Dromore, in Ireland; of Archbishop Tillotson; as well as of Bishops Burnet and Newton.

This doctrine is also generally maintained by those Christians who profess the Unitarian faith, whether Arians or Humanitarians. It has, however, been ably opposed by many learned men; though the controversy is now pretty much at rest.

UNIVERSITY. This term signifies the establishment of many colleges in one particular situation, all of which are subject to the same general government, and which are formed by the residence of numerous professors in every branch of science, who teach them to students assembled from all parts of Europe, and particularly the countries possessing those seats of learning.

So many centuries have elapsed since the introduction of this mode of instruction,

that each university is desirous to profit by the oblivion involving their origin, in claiming the priority: thus the members of the two universities of Paris and Boulogne assert that they were the first established; nor are those of Oxford and Cambridge less desirous of maintaining their real, or supposed, rights on this head.

As this is not the proper place to enter into an historical account of these vast seminaries of learning, we shall refer our readers, for further information in this particular, to works written expressly on the subject.

We shall now proceed to explain the various component parts of an university, and to accomplish this correctly and minutely, we have had recourse to the Cambridge University calendar, compiled by Mr. Raworth, who says, "The university of Cambridge is a society of students in all and every of the liberal arts and sciences, incorporated (13 Elizabeth) by the name of the chancellor, masters, and scholars. The frame of this little commonwealth standeth upon the union of sixteen colleges, or societies, devoted to the study of learning and knowledge, and for the better service of the church and state." Every college is in itself a corporate body, and governed by its own statutes, which must, however, concur with the general laws of the university, formed by Elizabeth on previous privileges, and confirmed by Parliament, consequently they are the basis of all modern regulations. Each of the colleges send deputies, both for the executive and legislative branches of the government, and the place of their meeting is termed the senate house.

Masters of arts, doctors in divinity, civil law, and physic, who have their names inscribed on the college boards, and are resident at Cambridge, possess votes in the above assembly; and of those there were, in the year 1802, about 940. The senate consists of two classes, which are called regents or non-regents, with a view to some particular offices assigned by the statutes of the university to the junior division. Masters of arts of less than five years standing, and doctors under two, form the regent, or upper house: and it has besides the term of white-hood house, from the circumstance of the members having their hoods lined with silk of the above colour: the remainder constitute the non-regent, or black-hood house: doctors of more than two years standing, and the public orator of the university, are entitled to vote in either of those houses at pleasure; exclusive of which there is a Caput, or council, composed of the vice chancellor, a doctor of each faculty, and two masters of arts, who are representatives of the houses already mentioned. The vice chancellor being a member of the Caput by virtue of his office, his election to the former only takes place annually, on the fourth of November, when the Senate choose him from the masters of the sixteen colleges; but that of the Caput occurs after the same interval on the 12th of October, in the following manner: the vice chancellor and the two proctors severally nominate five persons, and from the fifteen thus proposed the heads of colleges and doctors select five, generally preferring the vice chancellor's list.

The officer just mentioned calls the meetings of the senate by a printed notice, which specifies the cause, and must be suspended in the halls of the several colleges three days previously to the time appointed. A congregation of the members thus summoned may proceed to business, and a congregation consists of any number above twenty-six, including the proper officers of the Senate, who are compelled to attend on oath personally, or by their legal deputies. Exclusive of these casual meetings, there are statutable congregations, for conferring degrees, electing officers, &c. &c. which are held without notice. "Every member has a right," says Mr. Raworth, "to present any proposition, or grace, to the consideration of the Senate; but previously to its being voted by the two houses, it is to be read and approved by the Council, or Caput; each member of which has a negative voice. This custom has seldom been observed, unless something manifestly absurd, or obviously derogatory to the credit of the university, is proposed; insomuch, that nothing has been more common than for a person to give a placet in the Caput, and a non-placet to the same in the body, upon the idea that the Caput should be considered in the light of a committee to prepare the graces in point of form for the subsequent voting; as without some such regulation it might be difficult to take the sense of the Senate upon the real merits of the question." When a grace has passed the Caput, one of two scrutators read it in the non-regent house, and in the other it is read by the senior proctor, after which the vice chancellor dissolves the congregation; the ceremony of reading is repeated in a second congregation, and if a non-placet does not occur, it becomes a statute; on the contrary, if a non-placet is put in by a member of either

house, it is put to the vote there, and a majority decides the question.

The senatus consultum decree, or grace, of this learned assembly has the same force and effect as an act of the legislature of Great Britain, which fact is supported by the opinion of the best counsel, and, "in cases where nothing is enacted in opposition to the laws of the land, neither the statutes of Elizabeth, nor the mandatory letters of succeeding kings, although their authority be apparently strengthened by uninterrupted submission, can stand against the determination of this respectable assembly."

A degree cannot be conferred without passing of a grace for the purpose, which is done with the same formality as if a new law was to be made. This is, however, dispensed with in the single case of a bachelor of arts, as this requires reading in one congregation only, when it is termed a supplicat, and must be signed by the prælector, who thus becomes responsible for the truth of its contents, besides the penalty of being deprived of his privilege of voting in the Senate for two years, or bearing any office in the university, upon discovery of any false assertions in it. Degrees are never conferred, unless the persons receiving them previously sign a declaration, that they are *bona fide* members of the Church of England, as by law established. All the officers of the university, forming the executive part of it, are chosen by the Senate, the principal of whom is the chancellor, who presides in all cases, and to whom is confided the sole power of governing, excepting in cases of mayhem and felony; he is, besides, expected to protect and preserve all the rights and privileges of the institution, and to see that strict and impartial justice is administered in every case to the members; and that all this may be insured, the office has lately been entrusted to noblemen of the highest rank. Other parts of his official duty are, the convoking of assemblies, the sealing of diplomas, letters of degrees, provisions, &c. given by the university.

The high steward is the next officer in consequence to the chancellor, and to him is granted the power to superintend the trial of students accused of felony, within the limits of the jurisdiction, which is one mile in every direction from the suburbs of the university; he is also empowered to hold a leet, according to the established charter and custom, and is permitted to have a deputy.

The vice chancellor's office is explained by his title; but he acts as a magistrate for the university and county, and must be the head of some college. The regents elect two proctors, who are officers of the peace, and superintend the behaviour and discipline of all the pupils, and may search for and commit to prison those abandoned females who contribute to corrupt the morals of the students at the university. Exclusive of these purposes, the proctors are appointed to attend the congregations of the Senate, when they stand in scrutiny with the chancellor or vice chancellor, to take the open suffrages, verbally and written, which they read, and finally pronounce the assent or dissent; the graces are read by them in the regent house, where they take the assents and dissents secretly, but afterwards openly declare them. Although there are some particular parts of the duties of these officers which may be considered very unpleasant, yet they must be masters of arts, and are regents by virtue of their office, and are enabled to determine the seniority of all masters of arts at the time of their taking that degree; besides which, they may nominate two moderators, who are then appointed by a grace of the Senate. Those persons act as the substitutes of the proctors in the philosophical schools, and alternately superintend disputations and exercises there, and the examinations for the degree of bachelor of arts.

Other officers are termed taxors, scrutators, a public orator, a commissary, a registrar, esquire bedells, and librarians. The taxors, similar to the moderators, are masters of arts and regents by virtue of their office, which is to regulate the markets, the assize of bread, the exactness of weights and measures, by the different standards, and to summon all offenders into the commissary's court: the scrutators are non-regents, and their functions are to attend at every congregation, to read the graces in the lower house, where they collect the votes secretly or openly, in scrutiny, when they publicly pronounce the assent or dissent of that house.

The public orator holds an office which is considered as one of the most honourable in the university; he is, in fact, the medium of the Senate upon all solemn occasions, reading and recording all communications to and from the Senate, and presenting all honorary degrees, accompanied by a suitable speech. The commissary holds his office under the chancellor, and officiates as

assessor, or assistant, in the vice chancellor's court, besides which, he holds a court of record, where all causes are subject to the statute and civil law and custom of the university, and the persons for whom it is held are all privileged, and scholars under the degree of master of arts. The registrar attends himself, or by deputy, all congregations, to give directions, if necessary, for the correct wording of such graces as are propounded, and to draw up any that the vice chancellor may appoint, to receive them when passed through both houses, and to register them in the archives of the university exclusive of which, his office requires him to record the seniority of those who proceed annually in the arts or faculties, agreeably to the schedules furnished to him by the proctors.

The esquire bedells attend the vice chancellor during all public solemnities, preceding him with their insignia of silver maces: they attend, besides, the doctors when present in the regent house, by bringing them to open scrutiny, there to deliver their suffrages, either by word or writing, according to the order of the statute, and to receive from the vice-chancellor and the rest of the Caput the graces, which they deliver to the scrutators in the lower house, when, if granted, they convey them to the proctors in the other. Previous to a meeting, they proceed to every college, with an open summons, either to the Senate, or whatever else place may be appointed under the regulations of the university, and, finally, they attend the professors and respondents in each faculty from their several colleges to the schools, collect penalties and fines, and summon all members of the Senate to the chancellor's court.

We have now mentioned the different officers of an university in England, with as much brevity as the nature of the subject will permit, at the same time we must observe, that none can be more important in a state, or can more deserve explanation. There are two courts of law in the university of Cambridge the first of which is the consistory court of the chancellor, where that officer, or in his absence the vice chancellor, assisted by some of the heads of colleges, and one or more doctors of the civil law, preside, and administer justice demanded by any member of the university, or afford it to those who conceive themselves injured by them in the cases cognizable by this particular court; there all pleas and actions personal, originating within the jurisdiction of the university, to which a privileged person is a party, and not relating to mayhem or felony, is decided according to the usual course of civil law, by citation, libel, &c. When the cause relates to the sale or purchase of victuals, the chancellor is directed by the charters and customs of the body he governs, and in case they are silent upon the subject, the statutes of England are his guide. The decisions of this court are not absolute, as an appeal may be made to the Senate, which appoints three or five doctors, or masters of art, who are empowered to examine, confirm, or reverse the decree complained of.

The other court is the consistory court of the commissary. The commissary, a doctor of the civil law, acts under the authority and seal of the chancellor, and sits as well in the University, as at Midsummer and Sturbitch fairs, there to take knowledge, and to proceed in all causes "ad instantiam et promotionem partis ut supra," the parties, or one of them, being privileged saving that within the University all causes or suits whereunto the proctors, or taxors, or any of them, or a master of arts, or any other of superior degree, is a party, are reserved solely and wholly to the jurisdiction of the chancellor or vice chancellor. The manner of proceeding in this court is similar to that of the preceding, which has a registrar, procurators, and advocates, and a yeoman bedell, as is required in the consistory court. Appeals are also allowed, but in this case it must be made in the first instance to the higher court, and may from thence be removed to the Senate, and the three or five delegates appointed by that body.

The University possesses the right of sending two members to the Imperial Parliament of the United Kingdom, who are chosen by the collective body of the Senate. A council, termed the University council, appointed for various purposes, is composed by a grace of the Senate, and a solicitor is nominated by the vice chancellor.

The syndics, chosen from the members of the senate, conduct all special affairs, such as framing laws, regulating fees, and inspecting the library, the printing, buildings, &c. &c. Those of the University press cannot proceed to business unless the vice-chancellor and four others are present in the parlour of the office. All the professors of the sciences are allowed stipends, which are derived from various sources, composed of

the University chest, sums from government, or from estates appropriated for that purpose: the whole income of the University being about eleven thousand pounds per annum, including fees for degrees, profits of the printing office, &c. Of this sum eight thousand pounds is expended annually to officers, professors in the library and schools, the press, in taxes, and charitable donations, the whole under the management of the vice-chancellor for the time being, whose accounts are audited by three persons appointed yearly by the senate.

The Book of Statutes was printed in the year 1785, copies of which are possessed by the vice-chancellor and the proctors, and one is deposited in the public and in the libraries of each college; it consists of the ancient statutes, those of Henry VIII. Edward VI. and those of the first and twelfth years of the reign of Queen Elizabeth; "Literæ Regiæ ad Academiam datæ; Interpretationes Statutorum; Senatus consulta sive gratiæ decreta præfectorum; Juramenta et Formulæ." Mr. Raworth says, "the statutes of the twelfth of Elizabeth, and the Senatus Consulta, are those which are chiefly respected at this time. Many of the old statutes, decrees, interpretations, &c. are looked upon as obsolete, some as ridiculous, and others unnecessary in the present establishment; yet what Dr. Bentley observed of Trinity College statutes, during his disagreement with the fellows of that society, might be urged concerning these: "Some are my club, and others my rusty sword, which I can draw upon occasion."

The terms are three in number, Michaelmas term commences on the tenth of October, and terminates the sixteenth day of December; Lent term begins January thirteen, and is concluded on the Friday immediately preceding Palm Sunday; Midsummer term begins one week after Easter day, and ends on the Friday following commencement day, which is invariably the first Tuesday in July. Upon the decease of a member of the Senate during the term, and within the University, application is made to the vice-chancellor, and the bell of the University is tolled for one hour, term instantly commences for three days, and for that period lectures and disputations cease.

Most of the statutes made for the government of the sixteen different colleges dictate that the members or fellows of them shall be exclusively Englishmen, and some even prescribe that they must be natives of particular counties and districts; hence an invidious distinction is created between the residents of the northern and southern parts of this Island, which though united for a long time past in political matters, are most completely separated in the pursuit of knowledge, and it is too much to be feared that this circumstance is the real cause of the affected contempt of the degrees and academic honours granted by seminaries of learning in Scotland and Ireland. It is singular that the individuals who founded the colleges at Cambridge and Oxford should have concurred in this narrow and illiberal conduct almost universally, as they each had a strong sense of religion, which however does not appear to have taught them the best principle of it, brotherly love. As a few of the colleges admit of general competition for fellowships, and the members of the two Universities seem sensible of the injustice and impolicy of such distinctions, we may venture to hope some method will be devised ere long to obviate or remove them. The following regulation applies to all the colleges at Cambridge. "Whosoever hath one English parent, although he be born in another country, shall be esteemed as if born in that county to which his English parent belonged. But if both parents are English, he shall be reckoned of that county to which his father belonged."

The colleges are thus constituted: The head, by which odd term the master is designated, who is generally a doctor of divinity; but Caius college may be governed by a doctor of physic, and Trinity must have a doctor of laws; the principal of King's is styled provost, and of Queen's president. The fellows are generally bachelors of divinity, bachelors or masters of arts, and others are bachelors and doctors of law and physic, particularly at the two colleges of Trinity-hall and Caius. There is a distinction between the fellows, who are divided into classes, called regular and bye; the latter are considered as merely honorary, never succeeding to college preferment, nor having any concern whatever in the affairs of it, but are allowed an inconsiderable sum annually by their respective colleges, which act as trustees for them, they are denominated Perse Wortley, Yorkshire, Coventry, Platt, Dixie, and Tiverton. Clergymen who are termed conduits are employed in the several institutions as chaplains, and perform some of the duties belonging to that office.

There are noblemen graduates, doctors in the different faculties, and bachelors of divinity (who have been masters of arts), whose names are on the boards, and are all members of the Senate; they reside in the University occasionally, but have no further claim upon a college than the general respect due to their rank in the honours of the former; their charges are inconsiderable for keeping their names on the boards, being about four pounds per annum.

Graduates, neither members of the Senate, nor in statu pupillari are bachelors of divinity, and denominated four and twenty men, or ten-year men. These are generally clergymen that procure the dignities of the University in addition to their wealth and preferment at an easy rate, without the formalities of an education within its jurisdiction. Oxford does not permit this method of partaking of academic titles, and indeed the possessors of them enjoy but little reputation derived from such at Cambridge. They are tolerated by the statutes of Elizabeth, which allows persons who are admitted at any college, when twenty-four years of age, and upwards, after ten years (during the last two of which they must reside the greater part of three several terms) to become bachelors of divinity, without taking any prior degree.

Bachelors of law and physic sometimes put themselves to the unnecessary expense of keeping their names upon the boards till they obtain the distinction of doctors; bachelors of arts, on the contrary, who are in statu pupillari, and pay for tutorage, whether resident or non-resident, generally keep their names on the boards to evince their desire of becoming candidates for fellowships, or members of the Senate; they may, however, erase their names, and save the expenses of tutorage and college detriments, and take the degree of A. M. after the usual time, by inscribing their names a few days before their incepting, and paying a quarter's tutorage; some of these are called bachelors commoners, as they are allowed to dine with the fellows, and when under graduates they were fellow commoners.

The fellow commoners are almost universally the younger sons of titled persons, or the sons of men of ancient families and property; the denomination of those most probably originated from the privilege they enjoy of dining with the fellows. There are some few exclusive rights attached to the rank of fellow commoners, but they chiefly apply to the usages of the hall and chapel, besides which their academic habits are ornamented with gold or silver. Pensioners and scholars pay for their rooms, commons, &c. Those who enjoy scholarships read the graces, lessons in the ritual, &c. Of the sizars it has been observed, they are generally men of inferior fortune, though frequently by their merit they succeed to the highest honours in the University. They usually have their commons free, and receive various emoluments, by which means they are enabled creditably to proceed through their course of education. Most of our church dignitaries have been of this order.

Such is the general outline of an English University, a constitution the work of ages, with numerous perfections, and with very few errors; our confined limits will not permit us to enlarge as we could wish upon the forms adopted in the arduous undertaking of teaching the sciences and a taste for polite literature united, but we may safely say they seem such as are best calculated for the final purpose and to excite emulation, and we are supported in this assertion by the fact that no other Universities have excelled those of England and Great Britain, in the aggregate, in the production of excellent philosophers and respectable divines. Superficial knowledge is held in no kind of estimation at either of our great seminaries, the very essence and causes, as well as effects, must be explored to satisfy the expectations of the various professors, formed by long experience and unexhausted assiduity; a young man must therefore study vigorously, and without relaxation, for two years and one quarter, ere he ventures to appear in a public exercise before the University. The first year is occupied by lectures from Euclid, with the first six books of which he must be thoroughly acquainted, and the principles of algebra, plane trigonometry, and conic sections. Different colleges have their peculiar systems, but mechanics, hydrostatics, optics, fluxions, and a part of Newton's Principia, with the method of increments, differential method, and similar miscellanea, are the pursuits of the second year; to the third belongs astronomy, the Principia already mentioned, spherical trigonometry, the most difficult and important parts of fluxions, algebra, and geometry: his last term, or the first term of the fourth year, requires all the energies of his mind; he is now more deeply engaged in the arduous conflict of

the schools with all his rivals, and preparing himself for the Senate-house examination.

Having completed this course of natural philosophy, we shall next turn our attention to the mode adopted in the second head of academical studies, or the course of moral philosophy in the attainment of this branch. The first year is devoted to Locke and logic, and the two following to Paley, Hartley, Burlamagni, Rutherford, Clarke on the Attributes, and other authors whose writings are of a similar tendency, and those are made the subjects of various orders of lectures in the different colleges; lectures on the chronology, geography, laws, religious rites and customs of the nations which are mentioned in the Old and New Testaments, in some degree derived from Beausobre, but partly from other sources, are also given to promote an accurate knowledge of the foundation of our faith. Unfortunately, although these methods of promoting the studies of the pupils were wisely conceived, and are generally executed with great ability and advantage, there have been instances of neglect and very slight attendance.

The third head includes the belles lettres, or classics, and this of all the variety of pursuit seems the most successful in each of the colleges, as every term has an appropriate selection of the best for the lecture-room, when extracts from the most approved authors of antiquity, judiciously commented on, and compared with similar passages from modern writers, forms a source of entertainment highly grateful as well as useful. Besides the exertions of the tutor in this particular, the students deliver either written, or viva voce, compositions in their respective chapels weekly, which may be in the Latin or English languages. The author of the little but valuable work before mentioned, very properly observes, that emulation of an honourable kind is excited by prizes and rewards in most of the colleges, and this emulation is not of the dangerous nature too often perceptible in inferior seminaries, as the first man in each year feels his inferiority to those a few years older than himself, and the pre-eminence over his own year in his own college, may receive a most violent check in the collision with the rival heads of his own standing in fifteen other colleges.

UNXIA, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx five-leaved; leaflets ovate; florets of both disk and ray five; seed-down none; receptacle naked. There is but one species, viz. U. camphorata, a native of Surinam.

VOICE. The parts employed in the production of the voice are, the trachea or wind-pipe, by which the air passes to and from the lungs: the larynx, which is a short and cylindrical canal at the head of the trachea; and the glottis, which is a small oval chink between two semicircular membranes, extended horizontally from the entering side of the larynx.

The trachea so much resembles a flute, that the ancients attributed the formation of the voice to the trachea, as much as the formation of the sound to the body of the flute; and till the commencement of the last century, it was generally imagined that the trachea had at least a considerable part in the production of the voice. M. Dodart has established the contrary. He observed, that we neither speak nor sing in drawing in our breath, but only when we expel that which we have inhaled; and that the air thus expelled from the lungs passes through vessels, which increase in size as their distance from the lungs increases; and finally, through the trachea, which is the most capacious of any: so that the air, instead of being there confined and increasing in velocity, loses it. But the opening, denominated the glottis, being very narrow in comparison with the size of the trachea, the air can never pass through it without acquiring a considerable degree of velocity: so that the air thus compressed and forced on, communicates as it passes a vibratory motion to the particles of the two lips of the glottis, which produces that effect on the air which we call sound. The sound thus formed, passes into the cavity of the mouth and nostrils, where it reverberates; and Dodart proves, that this reverberation is what principally gives the effect to the voice. The different parts of the mouth, each in its turn, contributes to these reverberations, and modifies them; and it is this mixture of different reverberations, well proportioned to one another, which produces in the human voice a harmony which no instrument can equal. When the parts are defective, much of this pleasure is lost. It is, then, the cavity of the mouth, &c. that more properly answers to the body of the flute: the trachea only furnishes the air, like the sound-board of the organ.

The glottis, by means of different muscles, can be extended or shortened, can be dilated or contracted, and it is these changes which produce all the variety of tone. The narrower the opening the greater the rapidity with which the air passes, and the more acute the sound: hence those who wished to give their voice a very high tone, would suffocate themselves if they continued it sufficiently long, for, as they almost entirely close the glottis, very little air can issue, and they are in a similar situation with those whose respiration is stopped by hanging, drowning, &c. But if the opening of the glottis be too much dilated, the air will pass too easily to produce any vibration: hence those who wish to give their voice too deep a tone, cannot produce any sound.

This power of contraction and dilation is, perhaps, the most wonderful part of the mechanism of the voice. The diameter of the glottis never exceeds $\frac{1}{10}$th of an inch: now, suppose a person capable of sounding twelve notes (to which the voice easily reaches), there must be the difference of $\frac{1}{120}$th part of an inch for each note. But if we consider the subdivision of notes of which the voice is capable, the motion of the sides of the glottis appears still more minute, for if of two chords, so stretched as to be exactly in unison, one be shortened the $\frac{1}{200}$th part of its length, a correct ear will perceive the difference of the two sounds; and a good voice will sound the difference, which is only $\frac{1}{100}$th part of a note. But suppose that a voice can divide a note into 100 parts, it will follow that the different openings of the glottis will be 1200 in the $\frac{1}{10}$th of an inch, each of which will produce a sound perceptible to a good ear. But the movement of each side of the glottis being equal, it is necessary to double this number, and the side of the glottis actually divides the $\frac{1}{10}$th of an inch into 2400 equal parts, that each vibration is $\frac{1}{24000}$th part of an inch.

As yet we have simple, unarticulated sound, such as when we sing the notes of a tune without words. Speech is made up of articulated voice, that is, voice modified by the action, not of the lungs, the trachea, or the larynx, but of the throat, palate, teeth, tongue, and lips. Every variation in tone, however, is produced by a variation in the glottis, and in strength, by the action of the lungs: so that all the parts of this complicated mechanism are continually employed. Articulation begins when the voice has passed the larynx. The simplest articulate sounds are those which proceed from an open mouth: they are so little modified, that they are called in some other languages by the term voice, and in our own, from a derivative of the same word. In transmitting these, the apertures of the mouth may be pretty large, or somewhat smaller, or very small, which produces one set of the variations of vowel sounds: besides, in passing through the open mouth, the voice may be gently acted upon by the lips, or by the tongue and the palate, or by the tongue and throat, and hence another source of variation, and thus nine simple vowel sounds are produced. When the voice, in its passage through the mouth, is totally intercepted, or strongly compressed, there is formed a certain modification of articulate sounds, which is called a consonant. Silence is the effect of a total interception; and indistinct sound, of a strong compression: hence a consonant is not of itself a distinct articulate voice, and its influence, in varying the tones of language, cannot be perceived, unless it be accompanied with an opening of the mouth, that is by a vowel sound.

Such is the nature of the mechanism of the human voice, so complicated, yet so simple: and when we consider the great variety of motions necessary to be performed by every one who speaks with common fluency, instead of surprize that children are so long before they can articulate, and express a chain of ideas by words, we shall see ground for admiration that this most invaluable acquisition is made so early. The fact appears to be, that the powers of imitation are at that period the principal source of improvement, and the organs being then more capable of the requisite variation of flexure than in the later periods of life, sounds are acquired (not indeed without much trouble, and almost incessant exertion), which at the age of manhood baffle the best directed exertion.

VOIDED, in heraldry, is understood of an ordinary whose inner or middle part is cut out, leaving nothing but its edges to show its form, so that the field appears through it. Hence it is needless to express the colour or metal of the voided part, because it must of course be that of the field. The cross voided, differs from the cross fimbriated, in that the latter does not show the field through it, as the other does; and the same obtains in other ordinaries.

VOIDER, in heraldry, one of the ordi-

of using them. Sir William Hamilton also found it very great, and, dropping some pieces of wood into the fissures of a mass, situated four miles from the volcano, they immediately took fire; but Spallanzani illustrated this fact more decidedly, by passing a body of lava near the upper crater of Ætna, visibly red hot, even in full day-light, which had flowed from the mountain eleven months before.

It is supposed, that the volcanic fires of Iceland are very active and powerful, which is inferred from the incompetency of the blow-pipe to fuse the glass issuing from them. Vallisneri, describing a new volcanic island, which rose from the sea in the year 1707, near Santorine, asserts, that the sea in its vicinity became so violently heated, that vast numbers of fish perished, and were actually boiled; and it is well known, that the same cause melted the pitch in the seams of ships' bottoms, and occasioned their leaking: this modern fact is corroborated on the authority of Strabo, who declares, that the sea was observed to boil for four days, between Thera and Therasia. The complete fluidity of lava is another convincing proof of the excessive heat prevailing in the centre of volcanoes. M. Bottis produces two instances, derived from Vesuvius in 1771 and 1776, which demonstrate that this fiery mass assumes a state of liquidity almost equal to water: the Professor mentions four hills to have arisen suddenly in the first case near the aperture whence the larva proceeded, and from three of those in the shape of cones, issued streams of the melted matter, exactly resembling fountains of water. During the eruptions of the latter year, fresh lava, rushing from the crater, fell upon that of 1771, and rebounding from it into the air, there congealed in various figures capriciously ramified, and terminating in thin sharp points like needles. A circumstance observed by Sir William Hamilton, Count de Wilzeck, Cardinal Herzan, and the Archduke Maximilian of Austria, in the year 1775, seems to establish the fact, that the fluidity of the lava has been such at times, as to separate into portions, which, being thrown up from the crater, fell again near it, in a state so soft, that a guide who assisted in conducting these illustrious visitors, perceiving a fragment, passed his stick through it, and presented it thus to the Prince, who ordered both to be deposited in his private museum; this, however, seldom occurs, at least the indefatigable Spallanzani never discovered these fragments flattened or indented, as if they had fallen on some hard substance when in the consistence of paste.

With respect to the rapidity of its motion, this must greatly depend upon the quantity ejected, as well as the intensity of its heat: when an opportunity happens for attentive observation, the lava has been known to rise suddenly to the summit of the crater, and as suddenly overflowing its boundaries, rush down in various rivulets of fire; indeed Bottis compares it to "a liquor which boils in a vessel, and rises and overflows the edges of that vessel from the violence of the heat." The lava from Vesuvius, issuing in 1751, flowed over the space of twenty-eight palms in one minute; in 1754, it proceeded in two branches, at the rate of thirty feet in forty-five seconds, and afterwards uniting at thirty-three feet in fifty seconds: to these facts may be added the testimony of Sir William Hamilton, who thought its velocity in 1765, equal to that of the Severn, at the passage near Bristol. It may, however, be necessary to observe, that the fluidity of the matter does not always alone occasion its motion, which may be accelerated by a great descent, or the violent pressure of fresh lava constantly issuing from the source, particularly as lavas are known to harden when actually moving, so as to produce a sound when struck, and to bear stones thrown on their surface; but to place this fact beyond a doubt, Sir William Hamilton informs us, that himself and others, following the example of Mr. Jamineau, British Consul at Naples, actually crossed a moving mass above fifty feet in breadth; yet even thus circumstanced, those dreadful rivers of fire have been known to reach the sea eighteen, twenty, and even thirty miles from their commencement.

The arguments used to establish an idea that fires excited and maintained by human means, exceed those of volcanic origin in force, lie in a very small compass indeed; they are derived from observing, that some furnaces "vitrify lavas more decidedly than volcanoes, and melt schorls which remain perfect in the former." Dolomieu places this supposition in a clear point of view, in a memoir published by him of basaltes. "I shall again repeat," observes this celebrated French naturalist, "what cannot be too frequently inculcated, that lavas are not vitrifications; their fluidity is similar to that of metals reduced to fusion;

it does not change the order and manner of being, of the constituent parts of the lavas. When they cease to flow, they resume, like metals, the grain, texture, and all the characters of their primitive base; effects which we cannot produce upon stones in our furnaces, since we know not how to soften them by fire, without changing the manner in which they are aggregated. The fire of volcanoes has not that intensity which is supposed, and produces its effects rather by the extension and duration of its action than by its activity."

Arguing upon these various facts, and remarks of his own, leading to the same point, Spallanzani candidly acknowledges, that he had been more than once inclined to believe, that our fires possessed more energy than those of volcanoes; a number of experiments, however, induced him to say, that "these facts prove, first, that it is not always true, that volcanic fires are insufficient for the fusion of shorls; secondly, by the vitrification of the garnets, they confirm the powerful activity of those fires; thirdly, that those fires operate in a manner in some measure unknown to us; since, at the same time that they vitrify the garnets, they leave the base in which they are included in a state perfectly recognizable, notwithstanding that the former are refractory to the fire of the furnace, while the latter is easily fusible." It has been a generally received assertion, that volcanoes emit flame during eruption, and that flowing lavas are attended by the same accompaniment of fire; this supposition is erroneous, as may be proved by referring to the works of Serao, Father Torre, Bottis, and Sir William Hamilton, all of whom will be found to have omitted the observation of flames. The first expressly says of the lavas of Vesuvius, "that when seen by night, at any distance, they emit a light, not shining, like a bright flame, but of a dead kind, like that of red-hot substances which burn without flame;" and the last mentions, that he has "observed upon mount Vesuvius, that soon after a lava has borne down and burned a tree, a bright flame issues from its surface; otherwise I have never seen any flame attending an eruption:" adding, that the light reflected on the smoke, as it rises from the crater, by the raging of the fire in the gulph beneath, is frequently mistaken for flame. Spallanzani confirms the opinion of these accurate observers, and declares he never saw flame in, or proceeding from, any of the craters he examined.

Faujas thought it not improbable that fire united with water may produce some of those combinations of which we know not the origin; he says on this subject, "I almost incline to be of opinion, that the aqueous fluid, raised to a degree of ebullition and incandescence, of which our feeble furnaces can give us no idea, sometimes concurs with the inactive and concentrated fire which exists in the immense volcanic caverns, and that from this concurrence results a multitude of combinations hitherto unknown to us, which take effect on the stones and earths that remain perhaps whole ages in these burning gulphs, where the fire, intent to destroy, has for its adversary the water, which incessantly creates and opposes to it all the forms and modifications of which the matter is susceptible."

It will now be necessary to mention some of the effects of gas in the operations of these fierce internal fires: it is well known that their violent efforts to reach the surface of the liquified masses contained in craters causes it to rise suddenly from the bottom, completely filling their whole circumference, and at length forcing it over the sides in destructive streams, which overwhelm in their passage every object, either natural or artificial. Spallanzani made ten distinct experiments, in order to obtain some idea of the nature and effects of gas as exhibited by volcanoes; for this purpose he made use of different lavas, enamels, and glasses, ejected from them, and the consequence was, a conviction that the bubbles and inflations of various dimensions, observable in these substances, are not produced by the action of any permanent gas, "but by that of an aëriform fluid, produced by the excessive attenuation of those same products, in consequence of heat." Dr. Priestley made similar experiments, which differed in some degree from those related by the above celebrated Italian naturalist. The doctor fused 4¼ ounces of lava from Iceland in a sand-stone retort, and obtained twenty measures of air, half of which, at the commencement of the process, was carbonic acid gas, and the remainder, in purity 1.72, extinguished a candle; between the interstices of this lava was a sand, which the operator could not separate from it. Five ounces and an half of Vesuvian lava produced thirty measures of air, with a slight appearance of carbonic acid gas, the rest

was azotic gas, from the degree 1.64 to 1.38, with respect to what came last. On cooling, the residue broke the retort by its excessive inflation.

Without entering into an examination of the difference of opinion existing between these philosophers, we shall give an extract from the works of Spallanzani, that fully illustrates this part of our subject; "I shall," he observes, "now proceed to enquire what part this aëriform vapour acts in the eruptions of volcanoes. Where it exists in the depths of a volcanic crater, abundantly mixed with a liquid lava violently urged by subterranean conflagrations, I can easily conceive, that by its energetic force it may raise the lava to the top of the crater, and compel it to flow over the sides and form a current. Art can imitate this grand operation of nature on an infinitely less scale. I placed in a glass furnace a cylindric crucible, one foot high, and two inches and a half in breadth, which I filled half full with one of those volcanic products which most inflate and boil in the fire. After some hours, I observed that the liquid matter began slowly to rise, and afterwards to rise higher, until it at last overflowed the edges of the crucible, forming small streams down its sides, which, when they reached the plane on which the crucible stood, gave origin to small currents, if that plane was at all inclined. When I put more of the same product into the crucible, the currents became larger. If the plane was then taken from the surface, and the small currents, thus produced, examined, they were found full of minute bubbles, as was likewise the matter which remained in the crucible. This curious experiment I made with several glasses and volcanic enamels, as also with a variety of cellular lavas, and always with the same success."

Judging from the result of the above trial, it cannot be doubted that a similar elastic vapour, collecting in vast quantities under the surface of the earth, must, upon meeting with resistance in its passage, produce loud noises resembling thunder, and local tremblings of the surrounding earth, besides forcing its way upwards through super-incumbent lava: other experiments, made by Spallanzani, however, seem to prove that it must be another cause which expels the fiery matter with violence out of craters, as the matrasses he used broke without noise, and without ejecting or scattering the substance, and particularly, as the escape of gases has been frequently ascertained by the hissing sounds attending eruptions; unfortunately, though those vapours offer themselves to examination, it would be impossible to collect any part of them without exposing the life of the experimentalist to almost certain destruction, we must therefore admit their existence, and conjecture must supply the rest.

It will be recollected that all volcanoes, at present in a state of activity, are surrounded by, or situated very near, the sea, hence it appears clear, that the agency of that body is extremely powerful in promoting the violence of their eruptions, by rushing at uncertain intervals, and from unknown causes, through the caverns of the earth, upon the ever-enduring fires there existing; and this supposition is supported by the fact which has been repeatedly observed of the sudden retiring of the sea immediately preceding a violent explosion from a crater, the certain consequence of a rapid diminution of water on the shore. Little need be urged to prove the immediate and vehement separation that takes place upon the collision of fire and water, and of the force of steam thus produced; one instance however may be safely cited, which will place this supposed collision in a true light, and is extracted from the fourth volume of the "Memoirs of the Academy at Bologna." A bell of enormous dimensions had been ordered to be cast, at Modena, and preparations of the usual description were made under a spacious portico. After the metal had been completely melted, it was led into the mould, situated at a small depth under the pavement, through a small channel; the burning fluid had no sooner entered the mould than a dreadful explosion took place, which resembled in every particular the horrid effects of springing a mine; a deep hole was sunk in the earth, the metal, the mould, and every material of the portico above it, were scatterred in the air, and several persons were killed and severely wounded; if such were the immediate consequences of a trifling degree of moisture remaining in the sand which composed the mould, it may be naturally inferred, that a body of water, meeting with subterraneous fires, is capable of producing eruptions and earthquakes. It seems however extremely probable from experiments, that this effect principally arises from the insinuation of water under or below the surface of the sides of those fires, as it has been ascertained that water thrown upon fire evapo-

rates without much violence, and yet if the vapour thus generated is confined by superincumbent earth, or rocks, its struggles for a vent must occasion the violent disruption of those parts; the event is different on pouring water on melted tin, which is the only metal that is separated by this means so as to render it a dangerous operation to the experimentalist.

Spallanzani concludes many curious and interesting observations derived from experience, by saying, "from this series of experiments I think we are authorised to conclude, that when a quantity of water falls on the burning crater of a volcano, it has not the power of producing explosions; but that the latter on the contrary are very violent when the water penetrating below, reaches the conflagration; when suddenly reduced to vapour by the heat, it finds no room for its dilatation; or when it insinuates itself laterally among the liquified matters; of which we have a satisfactory proof in the explosion of the lava, violently forced from the containing vessel, on the introduction of water into a cavity made in it."

From what has been already said, a tolerable conception may be formed of the probable causes of volcanic eruptions, it now remains for us to add a concise narrative of their visible phenomena, and for this purpose we find ample materials furnished by Spallanzani, whose ascent of Stromboli deserves every praise for its courage, though we cannot help condemning him for the exercise of very daring temerity. The visit we allude to was made in 1788, when the appearance of the mountain was bifurcated, and the crater situated at some distance from the summits, from both of which the operations within it are distinctly visible, and from those the height of the ejections may be ascertained, with tolerable accuracy. During violent internal agitation the matter appears to ascend half a mile and more, but when the mountain is in actual eruption, the scattered fragments prove, that the impelling force is very greatly increased. After having attentively examined the crater from the summit above alluded to, Spallanzani approached the crater, where he found that the explosions succeeded each other so rapidly, that they might almost be said to occur without any intervals of quiet, but they varied in their force; the matter, in some instances, not rising more than fifty feet, and falling again into the crater; and in others it was elevated half a mile; the sounds, consequently, are proportionably loud, or the reverse, and resemble a hissing noise; the fragments of lava were actually fluid during their progress, which was evident from their globular shape, and becoming hard before they fell upon the sides of the mountain, that form is preserved.

The exhalations exhibited a thick cloud several miles in extent, which were strongly impregnated with sulphur; this cloud was impenetrable by the beams of the sun, and appeared very black in the midst, but white on the edges, and was, in all probability, a mile in depth. The vapour thus floating from the mountain was derived from three distinct sources, though doubtlessly produced by the same cause in the first instance: when an ejection of lava took place, it was always accompanied by a cloud of grey smoke from the crater; to the west of that spot were a number of obscure apertures, each of which sent forth a volume of similar vapour; and to the east, a vast cavern emitted a column at least twelve feet in diameter, extremely black and dense.

"Not satisfied with the observations I had already made," observes Spallanzani, "my curiosity impelled me to attempt further discoveries. From the pointed rock on which I stood, I could only see the edges of the inside of the crater, I considered, therefore, whether it might not be possible to obtain a sight of the lower parts likewise; and, looking round me, I perceived a small cavern hollowed in the rock, very near the gulph of the volcano, into which the rock above prevented the entrance of any burning stones, should they be thrown so far. It was likewise so elevated, that from it the crater was open to my view. I therefore hastened to take my station in this cavity, taking advantage of one of the very short intervals between the eruptions. To my great satisfaction, my expectations were completely fulfilled; I could here look down into the very bowels of the volcano, and truth and nature stood as it were unveiled before me." Thus situated in probable safety, the intrepid Spallanzani saw the following wonders.

The crater he found to be of a circular form, with edges composed of a chaos of sand, scoriæ, and lava; and he imagined the circumference to be about three hundred and forty feet. Similar to all other craters, that of Stromboli assumes the shape of a truncated inverted cone, the sides of which, from east to south, were gently in-

clined, but the remainder very steep. Many parts of this internal descent appeared to be incrusted with yellow substances, which he supposed to be the muriate of ammonia (sal ammoniac) or sulphur.

Fluid lava, resembling melted brass, red-hot, and liquid, filled the crater to a certain height, and this matter appeared to be influenced by two distinct impelling powers, the one whirling and agitated, and the other upwards; at times it rose rapidly, and when the surface had reached within thirty feet of the edges of the crater, an explosion took place like a short clap of thunder, and at the same instant, a portion of the lava was hurled with inconceivable swiftness into the air, which was as instantaneously separated into numerous fragments, and these were accompanied by a copious discharge of sand, ashes, and smoke. Immediately before the eruption occurred, the lava appeared inflated, and large bubbles, some several feet in diameter, rose and burst, the détonation followed, and the lava sunk, till a repetition of this operation was commenced; during the rising, a sound issued from the crater like that produced by a liquid boiling violently in a cauldron. Many of the eruptions were so inconsiderable, that their effect could not be visible at a small distance from the mountain; in those the fragments constantly fell back into the gulph, with a sound, on their collision with the great mass of matter, similar to that produced by water when forcibly struck with flat staves: in the greater explosions, many of the pieces returned into the crater, some falling on the sides and rolling down, but many descended a precipice, formed by one side of the mountain, to the sea.

The pieces of scoriaceous lava, as they moved in the air, retained their red-hot appearance, though the sun shone clear; many of them came in contact during their progress, and, according to the degree of heat they possessed, they adhered, or were broken. The smoke seemed to be foreign to the lava, as none attended the fragments thrown into the air, and that which escaped, passed through fissures, and at the moment the lava burst. According to Spallanzani's conjectures, the crater may be about twenty-five or thirty feet in depth, when the lava is raised to its greatest height, and upon its subsiding, forty or fifty. There are no visible marks of its ever having overflowed so as to descend like those of Ætna and Vesuvius.

"Though the ejections of the larger and heavier stones have short intermissions, those of the lesser and lighter have scarcely any. Did not the eye perceive how those showers of stones originate, it would be supposed that they fell from the sky: the noise of the more violent eruptions, resembling that of thunder, and the darkness occasioned by the mounting cloud of smoke, present the image of a tempest."

While this naturalist was employed in intense observation, the eruption suddenly ceased, the lava sunk to a greater depth than usual, and remained thus depressed; the fierce light subsided, and at the same instant the various streams of smoke, issuing before silently from the apertures west of the crater, began to rush forth with a loud hissing noise, and the apertures to shine with a bright colour of fire. "I know nothing," says Spallanzani, "to which the sound produced by the issuing of these fumes can be more properly compared than the blowing of large bellows into a furnace by which metals are melted; such as I have seen at Zalatna, in Transylvania, and Schemnitz and Kremnitz, in Hungary, except that those volcanic bellows roared a hundred times louder, and almost deafened the ear."

We cannot conclude this article more properly than by giving an account of the crater of Ætna, as it was examined by the above author, to which he ascended with equal danger and difficulty, and where he was compelled to sit nearly two hours ere he could commence his observations: he then says, "I viewed with astonishment the configuration of the borders, the internal sides, the form of the immense cavern, its bottom, an aperture which appeared in it, the melted matter which boiled within, and the smoke which ascended from it. The whole of this stupendous scene was distinctly displayed before me; and I shall now proceed to give some description of it, though it will only be possible to present the reader with a very feeble image, as the sight alone can enable him to form ideas at all adequate to objects so grand and astonishing. The upper edges of the crater, to judge by the eye, are about a mile and a half in circuit, and form an oval, the longest diameter of which extends from east to west. As they are in several places broken, and crumbled away in large fragments, they appear as it were indented, and these indentations are a kind of enormous steps, formed of projecting lavas and scoriæ. The internal sides of the cavern, or crater, are

inclined in different angles in different places: "on the west the inclination is gentle; on the north the steepness increases; and from this point to the south-east the descent becomes more sudden, till, where the observer stood, they were almost perpendicular. The funnel-shape, however, still prevails, as in every other instance, and the surface was extremely rugged, and strewed with concretions of an orange colour, which proved to be the muriate of ammonia; and it is very probable that the numerous stripes of yellow on the nearly horizontal plane at the bottom may be the same substance. "In this plain, from the place where I stood, a circular aperture was visible, apparently about five poles in diameter, from which issued the larger column of smoke, which I had seen before I arrived at the summit of Ætna. I shall not mention several streams of smoke which arose like thin clouds from the same bottom, and different places in the sides. The principal column, which at its origin might be about twenty feet in diameter, ascended rapidly in a perpendicular direction while it was within the crater; but when it had risen above the edges inclined towards the west, from the action of a light wind; and when it had risen higher, dilated into an extended but thin volume. This smoke was white, and being impelled to the side opposite to that on which I was, did not prevent my seeing within the aperture; in which I can affirm, I very distinctly perceived a liquid ignited matter, which continually undulated, boiled, and rose and fell, without spreading over the bottom. This certainly was the melted lava, which had arisen to that aperture from the bottom of the Ætnean gulph."

Being favourably situated for observing the effects of external violence on the liquid matter within the aperture, the abbe rolled large fragments of lava down the side, which entering the opening, produced a sound resembling the sudden immersion of a heavy substance in a thick tenacious paste. In performing this experiment, the effect was multiplied by the stones loosening others in their passage, some of which fell on the plane; those rebounding, even when very large, caused a sound extremely different from the others that struck the liquid lava: this circumstance proves, that, though the bottom may be a comparatively thin covering of the gulph, it is capable of great resistance. We shall proceed with a short notice of

VOLCANOES *in the moon.* As the moon has on its surface mountains and valleys in common with the earth, some modern astronomers have discovered a still greater similarity, *viz.* that some of these are really volcanoes, emitting fire as those on earth do. An appearance of this kind was discovered some years ago by Don Ulloa in an eclipse of the sun. It was a small bright spot, like a star, near the margin of the moon, and which he at that time supposed to have been a hole, with the sun's light shining through it. Succeeding observations, however, have induced astronomers to attribute appearances of this kind to the eruption of volcanic fire; and Dr. Herschel has particularly observed several eruptions of the lunar volcanoes, the last of which he gives an account of in the Philosophical Transactions for 1787. "April 19, 10^h 36^m, sidereal time. I perceive (says he) three volcanoes in different places of the dark part of the new moon. Two of them are either already nearly extinct, or otherwise in a state of going to break out; which perhaps may be decided next lunation. The third shows an actual eruption of fire, or luminous matter. I measured the distance of the crater from the northern limb of the moon, and found it $3' 57.3''$: its light is much brighter than the nucleus of the comet which M. Mechain discovered at Paris the 10th of this month.

"April 20, 10^h 2^m sidereal time. The volcano burns with greater violence than last night. Its diameter cannot be less than $3''$ by comparing it with that of the Georgian planet: as Jupiter was near at hand, I turned the telescope to his third satellite, and estimated the diameter of the burning part of the volcano to be equal to at least twice that of the satellite: whence we may compute that the shining or burning matter must be above three miles in diameter. It is of an irregular round figure, and very sharply defined on the edges. The other two volcanoes are much further towards the centre of the moon, and resemble large, pretty faint nebulæ, that are gradually much brighter in the middle; but no well-defined luminous spot can be discerned in them. These three spots are plainly to be distinguished from the rest of the marks upon the moon; for the reflection of the sun's rays from the earth is, in its present situation, sufficiently bright, with a ten feet reflector, to show the moon's spots, even the darkest of them; nor did I perceive any similar phenomena last lunation, though

I then viewed the same places with the same instrument.

"The appearance of what I have called the actual fire, or eruption of a volcano, exactly resembled a small piece of burning charcoal when it is covered by a very thin coat of white ashes, which frequently adhere to it when it has been some time ignited; and it has a degree of brightness about as strong as that with which such a coal would be seen to glow in faint daylight. All the adjacent parts of the volcanic mountain seemed to be faintly illuminated by the eruption, and were gradually more obscure as they lay at a greater distance from the crater. This eruption resembled much that which I saw on the 4th of May, in the year 1783, but differed considerably in magnitude and brightness; for the volcano of the year 1783, though much brighter than that which is now burning, was not nearly so large in the dimensions of its eruption: the former seen in the telescope resembled a star of the fourth magnitude as it appears to the naked eye; this, on the contrary, shows a visible disc of luminous matter very different from the sparkling brightness of star light."

VOLKAMERIA, in botany, so named in memory of John George Volkamer, physician at Nuremburg, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Vitices, Jussieu. Essential character: calyx five-cleft; corolla segments directed the same way; drupe two-seeded; nuts two-celled. There are eight species.

VOLITION. See WILL.

VOLUNTARY, in music, is an extempore performance upon, or a composition written for the organ, and serving to relieve and embellish divine service.

VOLVOX, in natural history, a genus of the Vermes Infusoria class and order. Worm invisible to the naked eye, simple, pellucid, spherical. There are nine species. V. sphærula is, as its name denotes, spherical, with similar rounded molecules. It is seen in stagnant waters. Body composed of about sixty pellucid homogeneous transparent or greenish-yellow points, moves slowly about a quarter of a circle from right to left, and then back again from left to right.

VOLUTA, in natural history, a genus of the Vermes Testacea class and order. Animal a limax; shell one-celled spiral; aperture without a beak, and somewhat effuse; pillar twisted, or plaited, generally without lips or perforation. There are nearly two hundred species in sections. A. aperture intire; B. subcylindrical emarginate; C. oboval effuse emarginate; D. fusiform; E. ventricose; spire papillary at the tip. In the first section is V. auris midæ; shell contracted, oval, oblong, with rugged spire; pillar two-toothed. It inhabits India, in marshy woods and swamps, and very much resembles an helix; about four inches long; shell brown, solid, wrinkled or striate; spire large, with from six to nine whorls, each terminated by a granulated band, the outer ones cancellate; aperture long, wider beneath. In section D we may notice V. episcopalis; shell emarginate, smooth; margins of the whorls intire; lip denticulate; pillar with four plaits. It inhabits India. The inhabitant, or fish, is said to be of a poisonous nature, if eaten, and to wound those who touch it with a kind of pointed trunk. The natives of the island of Tanna fix the shells in handles, and use them as hatchets.

VOLUTE, in architecture, a kind of spiral scroll, used in the Ionic and Composite capital, whereof it makes the principal characteristic and ornament.

VORTICELLA, in natural history, a genus of Vermes Infusoria class and order. Body contractile, naked, and furnished with ciliate rotatory organs. There are about fifty or sixty species in sections. A. Seated on a pedicle, or stem. B. Furnished with a tail. C. Without a tail. V. anastatica is compound, bell-shaped, with an oblique mouth and scaly rigid stem. It inhabits fresh waters, forming clusters branched out in various directions; ovaries seated on the stems in the form of bulbs, which detach themselves from the stems, and fix themselves to other substances, producing a new cluster. V. nasuta is cylindrical, with a projecting point in the middle of the cup. It is found in stagnant water, invisible to the naked eye, pellucid, changing its form perpetually, quick in motion, and having a rotatory organ surrounding the middle of the body.

VOSSIUS (GERARD JOHN), in biography, one of the most learned and laborious writers of the seventeenth century, was of a considerable family in the Netherlands; and was born in 1577, near Heidelberg, at a place where his father, John Vossius, was minister. He first learned Latin, Greek, and Philosophy, at Dort, where his father had settled, and died. In 1595, he went to Leyden, where he further

pursued these studies, joining mathematics to them, in which science he made a considerable progress. He became Master of Arts and Doctor in Philosophy in 1598; and soon after Director of the College at Dort; and, in 1618, Professor of Eloquence and Chronology in the academy there, the same year in which appeared his "History of the Pelagian Controversy." This history procured him much odium and disgrace on the Continent, but an ample reward in England, where Archbishop Laud obtained leave of King Charles I. for Vossius to hold a prebendary in the church of Canterbury, while he resided at Leyden. This was in 1629, when he came over to be installed, took a Doctor of Laws degree at Oxford, and then returned.

In 1633, he was called to Amsterdam to fill the chair of a Professor of History; where he died in 1649, at seventy-two years of age: after having written and published as many works as, when they came to be collected and printed at Amsterdam in 1695, &c., made six volumes folio.

VOTES. The decision of any question by an assembly of persons being in its own nature impracticable in the case of dissent, by one or more of the individuals, it becomes an object of practical necessity to provide for that case, in most instances, by some expedient. In our English law the determination of twelve men upon a jury is rendered unanimous by annexing the condition, that they shall not delay longer than it shall be possible for them to subsist without the necessaries of life. Upon almost any other occasion it has been established that the wish of the majority shall be taken as the sense of the whole.

This last rule is, however, capable of many modifications, one of the most striking is, that which is used in all arrangements of delegation. In order to insure the possession of knowledge, fidelity, diligence, and dispatch, it is usual in society to perform the business of the public by delegates, in successive order of power and responsibility. Thus, a large and mixed multitude, possessing very little political knowledge, liable for the most part to be misled by prejudices or corruption, incapable, on many accounts, of pursuing objects with steadiness, and from their number absolutely unable to deliberate or decide, with the smallest degree of efficacy, may nevertheless be very capable of determining the single question who shall be their delegate in a less numerous assembly of wise and virtuous men; and this last assembly may give power to their chairman and their committees to perform many acts which could scarcely be effected by themselves in their entire mass.

These proceedings, however, are supposed to have the determination of single questions in view at a time; but there are questions of vote which in their own nature possess a degree of complexity. Into these our limits will not allow us to enter, but there is one relating to personal elections, which Borda, in his Memoirs of the French Academy, has pointed out, and is intitled to our notice. It relates to the choice of one out of a number of candidates, which is made simply by taking him who has the majority of voices, but which may not coincide with the wish of the electors, and may even be that which is the most opposite to that wish.

The example is, suppose these candidates, A, B, and C, had twenty-one electors; then if A have eight votes, B seven, and C six, A will be elected. But the truth here manifested is, that eight voters out of twenty-one give the preference to A beyond B and C, and it is not known in what order of preference those voters place these two last. A like observation may be made as to the other sets who have voted in preference for B and C. So that if the seven voters for B had possessed the means of showing, and had declared their preference of C to A, C would have had thirteen votes, and prevailed against A; and there is nothing in this cause of election which can show that this would not have been the result.

Mr. B. proposes that this should be remedied by each voter giving in a list of the order of merit in the candidates, and he shows at length, by mathematical reasoning, the true indication to be deduced from such lists. But as this practice might probably be too remote from vulgar apprehension to be much approved, it may be sufficient to refer the reader to the Memoir, and to remark that, in order to be certain that an election, made in the common way, is really the wish of the majority, it is necessary that the number of votes obtained by the successful candidate should be to the whole number of electors, in a greater ratio than the number of candidates by one to their total number.

VOWEL, in grammar, a letter which affords a complete sound of itself, or a letter so simple as only to need a bare opening of

the mouth to make it heard, and to form a distinct voice. See GRAMMAR.

The vowels are six in number, viz. A, E, I, O, U, Y, and are called vowels in contradistinction to certain other letters, which depending on a particular application of some part of the mouth, as the teeth, lips, or palate, can make no perfect sound without an opening of the mouth, that is, without the addition of a vowel, and are therefore called consonants.

UPRIGHT, in heraldry, is used in respect of shell fishes, as crevices, &c. when standing erect in a coat.

UPUPA, the *hoopoe*, in natural history, a genus of birds of the order Picæ. Generic character: bill long, slender, and bending; nostrils in the base of the bill; tongue obtuse, entire, and triangular; middle toe of the three toes before, connected in some degree to the outermost. There are eight species, of which the following deserve the chief notice. U. epops, common hoopoe;- this weighs three ounces, and is a foot long; is found in Europe, Asia, and Africa; but, even in the warmest countries of Europe, is said to be migratory. In England it is by no means abundant. It is devoted to solitude, and rarely seen even in pairs. At Cairo, however, in Egypt, these birds appear in small flocks, and build on the terraces of houses fronting the bustle and noises of the street. They seldom perch on trees, confining themselves almost entirely to the ground. When agitated by strong passion, whether of surprise or anger, of fear or attachment, they erect their crests and spread their tails with great fullness and intensity. They feed upon insects, and give them to their young; and their nests are, for want of that cleanly management for which birds are generally distinguished, intolerably disgusting to the smell, in consequence of the putrid remains of this species of food. In confinement they will live on bread and cheese, or raw meat. See Aves, Plate XIV. fig. 4.

U. promerops is about four feet long, but the body is little larger than that of a pigeon. Its plumage is of the most various, beautiful, and brilliant colour, and strongly reminds the observer of the bird of paradise, to which, indeed, it is considered as allied. It is found in New Guinea, and employed by the natives as one of the most striking personal embellishments.

URAN, in mineralogy, a genus of ores containing three species. 1. "Pitch-ore," of a velvet-black colour, inclining to iron-black; it occurs almost always massive and disseminated: specific gravity between 6.3 and 7.5. It is completely infusible, without addition, before the blow-pipe. With soda, or borax, it forms a grey, slaggy globule; with phosphoric salts a transparent green bead. It dissolves imperfectly in sulphuric and muriatic acids; but is nearly dissolved in nitrous and nitro-muriatic acids. It consists of

Uran	86.5
Oxide of iron	2.5
Sulphorated lead	6.0
Silica	5.0
	100.0

It occurs in veins, in primitive mountains, with lead and siver ores; and is usually accompanied with lead glance, copper pyrites, iron ochre, &c. It is found in Saxony and Norway, and is distinguished from brown-blende by colour, specific gravity, fracture, and streak; from wolfram by its streak and fracture.

The chief colour of the second species, uran-micá, is grass-green: specific gravity 3.1. It dissolves in nitrous acid without effervescence, and communicates to it a lemon-yellow colour. It consists of an oxide of uran, with a slight admixture of copper. It occurs in ironstone veins, in Cornwall, Germany, and France. It is not like mica, to which it has a great resemblance, elastic.

The third species is uran-ochre, which is of a straw-yellow colour: it occurs usually as a coating or efflorescence on pitch ore. From the ore we have

URANIUM, in chemistry, a metal discovered by Klaproth in the year 1789. It was then announced as a metal more difficult to be reduced than manganese, externally of a grey colour, and internally of a clear brown, of considerable lustre, and middling hardness, that it might be scratched and filed, and that its oxide gives a deep orange colour to porcelain. It has been obtained from three different minerals. The first is in the state of sulphuret, of a blackish colour, and of a shining fracture, and sometimes lamellated. In this state it is sometimes combined with iron and sulphureted lead. The uranium is in the metallic state.

The second ore from which this metal is obtained, is the native oxide of uranium. It is always in the state of yellow powder, on the surface of the sulphuret. The specific gravity is 3.24. When it is of a pure yellow colour it is then a pure oxide.

The third ore of the metal is the native carbonate of uranium. Of this there are two distinct varieties, the one of a pale green, and sometimes of a silvery-white colour. This contains but a small quantity of the oxide of copper, and is very rare. The other is of a shining deep green, which is the green mica, or glimmer, of mineralogists. Klaproth supposed that it contained an oxide of uranium, mixed with the oxide of copper; but it has been since discovered to have carbonic acid in its composition. It is crystallized in small square plates, and sometimes, though rarely, in complete octahedrons.

The process by which Klaproth reduced this metal is the following: He mixed the yellow oxide of uranium, precipitated from its solutions by an alkali, with linseed oil, in the form of a paste, and this being exposed to a strong heat, there remained a black powder, which had lost rather more than one-fourth of its weight. It was then exposed to the heat of a porcelain furnace, in a close crucible, and the oxide was afterwards found in a coherent mass, but friable under the fingers, and reduced to a black shining powder. It decomposed nitric acid with effervescence. This black powder, covered with calcined borax, was for the second time exposed to a still stronger heat, by which a metallic mass was obtained, consisting of very small globules adhering together.

The colour of uranium is of a dark grey, and internally of a pale brown. It has little brilliancy, on account of the spongy mass in which state it is obtained. It may be scratched with a knife, and is extremely infusible. The specific gravity is 6.4. When uranium is exposed to a red heat in the open air, or when it is acted on by the blow-pipe, it undergoes no change. The yellow oxide of uranium does not melt. It acquires a brownish-grey colour when it is long heated in the air, but it has not been ascertained whether it gains or loses oxygen. The oxide of uranium is reduced by means of charcoal, when it is exposed to heat. The yellow oxide, when mixed with common enamelling flux, tinges porcelain of a deep orange colour.

URANIA, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Musæ, Jussieu. Essential character: calyx none; corolla three-petalled; nectary two-leaved, with one of the leaves bifid; capsule inferior, three-celled, many-seeded; seeds in two rows, covered with an aril. There is only one species, viz. U. speciosa, a lofty tree, growing naturally in the marshy places of Madagascar.

URANOSCOPUS, the *star-gazer*, in natural history, a genus of fishes of the order Jugulares. Generic character: head large, depressed, rough; mouth with an internal cirrus; gill-membrane with six papillous-toothed rays; gill-covers edged with a membranaceous fringe.

U. scaber, or the bearded star-gazer, is a native of the Mediterranean, and frequents deep places near the shores, feeding on aquatic insects and small fishes, which it decoys within its reach by waving the long cirrus of the mouth in various directions. The smaller fishes mistake these for worms, and in endeavouring to seize the supposed food are themselves caught and devoured by the star-gazer, which lay imbedded and unobserved in the mud or gravel of the bottom.

URENA, in botany, a genus of the Monadelphia Polyandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character: calyx double, outer five-cleft; capsule five-cleft, divisible into five parts, with the cells closed, and one seed in each. There are eight species.

URETHRA. See ANATOMY.

UREA, in chemistry. The nature and properties of urea have been chiefly investigated by Fourcroy and Vauquelin. It is obtained from urine. It may be extracted by the following process: If a quantity of human urine which has been passed a few hours after taking food, be evaporated with a gentle heat, to the consistence of a thick syrup, and allowed to cool, it concretes into a crystalline mass. Add to this mass, in separate portions, four times its weight of alcohol; with the application of a gentle heat, great part is dissolved, and what remains consists of different saline substances. Separate the solution from the undissolved part, and introduce it into a retort. Distil with the heat of a sand-bath, and continue the boiling till the liquid is reduced to the form of a thick syrup. The matter which remains in the retort crystallizes as it cools. The crystals thus formed are urea.

Urea, which is prepared by this process, is crystallized in the form of plates, crossing each other. It is viscid, resembling thick honey, and of a yellowish-white colour. It has a strong acrid taste, and a fetid alliaceous smell. It deliquesces in the air, and by attracting moisture is converted into a thick

brown liquid. It is very soluble in water, and also in alcohol. The solution in water concentrated, is of a brown colour. This solution is gradually decomposed, air is emitted, which is partly composed of ammonia, and acetic acid is formed in the liquid. If the solution in water be boiled, and as the evaporation goes on fresh portions of water be added, the urea is decomposed; carbonate of ammonia is disengaged, while acetic acid is formed, and charcoal precipitated. The component parts of urea, therefore, are supposed to be

Oxygen	39.5
Azote	32.5
Carbon	14.7
Hydrogen	13.3
	100.0

The caustic fixed alkalies readily dissolve urea, and disengage from it ammonia; and the solution contains the benzoic, acetous, and carbonic acids, united with the alkali employed. The urea almost entirely disappears from urine during certain diseases, and a very large quantity of saccharine matter is produced, which when evaporated and clarified resembles Muscovado sugar.

URIC *acid*. This acid was discovered by Scheele in the year 1776. It was at first called lithic acid. It constitutes one of the component parts of urinary calculi, and is also found in human urine. There is one species of calculus which is almost entirely composed of this substance; it is that species which resembles wood in appearance and colour. This acid is insipid, inodorous, almost insoluble in cold water, and soluble only in about 360 parts of boiling water. It separates from this when it cools, into small yellowish crystals. The solution in water reddens the tincture of turnsole. There is scarcely any action between the uric acid and the sulphuric and muriatic acids. It is soluble in the concentrated nitric acid, to which it communicates a red colour. It would appear that in this change of colour the nature of the acid is also changed, for part of it is converted into oxalic acid. Oxymuriatic acid very readily acts upon uric acid, either by suspending a calculus in the liquid acid, or, which is easier, by passing a stream of oxymuriatic acid gas through water, at the bottom of which is placed the uric acid in powder. Its colour becomes pale, the surface swells up, it softens, and is at last converted into a jelly. This part disappears, and is soon dissolved, giving a milky colour to the liquid. There is extricated, by slow effervescence, small bubbles of carbonic acid gas. The liquid by evaporation gives muriate of ammonia, acidulous oxalate of ammonia, both crystallized; muriatic acid, and malic acid. Thus the oxymuriatic acid decomposes the uric acid, and converts it into ammonia, carbonic, oxalic, and malic acids. Various facts show that uric acid is a compound of a very peculiar kind, formed of azote, of carbon, of hydrogen, and oxygen, and susceptible of a great number of different changes by chemical agents.

URINE. The properties of urine vary considerably, according to the constitution and health of the body, and the period when it is voided after taking food. The urine of a healthy person is of a light orange colour, and uniformly transparent. It has a slightly aromatic odour, in some degree resembling that of violets. It has a slightly acrid, saline, bitter taste. The specific gravity varies from 1.005 to 1.033. The aromatic odour, which leaves it as it cools, is succeeded by what is called the urinous smell, which latter is converted to another, and, finally, to an alkaline odour. Urine converts the tincture of turnsole into a green colour, from which it is concluded that it contains an acid. No less than thirty different substances have been detected in urine by chemical analysis; viz. a great variety of salts, acids, ammonia, &c.

Urine is much disposed to spontaneous decomposition. The time when this process commences, and the rapidity of the changes which take place, depend on the quantity of the gelatine and albumen. When the proportion of these substances is considerable, the decomposition is very rapid. This is owing to the great number of substances, and the united force of their attractions overcoming the existing affinities of the different compounds of which fresh urine consists, and especially to the facility with which urea is decomposed. This substance is converted during putrefaction into ammonia, carbonic acid, and acetic acid. Hence the smell of ammonia is always recognized while urine is undergoing these changes. Part of the gelatine is deposited in a flaky form, mixed with mucilage. Ammonia combines with phosphoric acid, and the phosphate of lime is precipitated. It combines also with phosphate of magnesia, and forms a triple salt. The other acids, the uric, benzoic, the acetic, and carbonic acids, are all saturated with ammonia. See PHYSIOLOGY.

URSUS, the *bear*, in natural history, a genus of Mammalia, of the order Feræ. Generic character: six front teeth both above and below, the two lateral ones of the lower jaw lobed, and longer than the others, with smaller or secondary teeth at the internal bases; tusks solitary; five or six grinders on each side, the first approaching the tusks; tongue smooth; snout prominent; eyes furnished with a nictitating membrane. There are ten species.

U. arctos, the brown bear, is met with in almost all the northern territories of Europe and Asia, and lives solitary in remote forests, subsisting principally on fruits and other vegetable substances, and occasionally devouring animals. It is particularly fond of honey, and is said to possess great sagacity in discovering it; and will ascend high trees to obtain it. It frequently resides in the hollows of trees, and sometimes fixes its habitation in the banks of rivers, for the sake of fish, which it sometimes takes and devours. Towards the close of autumn, it retires to its habitation in a state highly fleshy and fat, and remains for weeks together without food, and almost without motion. The female withdraws to the most obscure recesses at the same time, to produce her young, which are in general no more than two, extremely small, and in form little resembling the future full-grown animal. During the first month these are blind; for four months they are attended by the dam with such vigilance and tenderness, that she almost abstains from her own necessary nourishment. After a certain period, the female returns to the den of the male with her young, which it was necessary for a time to secrete from him, lest he should devour them; and in spring they quit their cavern, and range with great voracity, after their long confinement, in pursuit of food. They will climb trees with great alacrity, and strip them almost completely of their fruit. The date tree is a particular favourite with them. These animals are often taken young, and subdued to a great degree of tameness and docility, and taught a variety of tricks and dances: but the discipline of torture is applied to produce these effects; and the extreme cruelty requisite to accomplish these creatures for the usual exhibitions they are instructed to make, are a disgrace to civilized society, and worthy of the interference of legislation. Bears were formerly common in Greece; and even in this country they once existed, and were guarded with jealousy by the forest laws, as beasts of chace; and after their extermination they were imported for the diversion of baiting them, which was an entertainment displayed in honour of nobles and princes. They were exhibited, from Africa, in the grand spectacles at Rome. See Mammalia, Plate XXI. fig. 4.

U. Americanus, or the American bear, has a long pointed nose, and is generally smaller than the above species. It abounds in the northern territories of America, and is said to live exclusively on vegetable food, extreme hunger only being able to induce it to eat the flesh of animals. These bears reside in trees, mounting and descending them with great alertness. Their skins form an important article of merchandize; their flesh, when young, is thought delicious; and their fat is thought an admirable application for sprains and bruises. They are taken frequently by setting fire to the trees which they inhabit.

U. maritimus, or the Polar bear, is nearly double the size of the common bear, and is stated to have been seen of the length of twelve feet. It is completely white. Its principal residence is on the shores of Greenland and Hudson's Bay, and it inhabits only the coldest regions of the world. It possesses the most formidable strength and ferocity. The sailors of Barentz, in his voyage in quest of a north-east passage to China, were assaulted in their boat by these animals, carried off, and devoured within the view of their companions. They will attempt to board armed ships, and, defying every obstacle with the most fearless energy, have sometimes only with the greatest difficulty been prevented. They subsist on fishes, seals, and whales, at sea; and by land devour birds, hares, deer, and various other animals; and will also eat berries and various other vegetables. In Greenland they sometimes surround the habitations of the natives, allured by the strong smell of the seal oil, and attempt to break through to commit their depredations; but are reported to be effectually repelled by the smell of burnt feathers. In winter they ingulph themselves in the snow, or immure themselves in some cavern, where they pass in torpor the Polar night, making their egress only with the re-appearance of the sun: in summer they are often found on large masses of floating ice at sea, and, swimming with great excellence, they pass from one of these to another with much facility; they are sometimes, however, car-

ried to vast distances from land, and perish for want of the means of subsistence. They produce generally two young ones at a birth, and the attachment between these and the dam is one of the strongest exhibited in the whole animal creation. The natives of Kamtschatka always avoid firing at a young bear if the dam be present, as the rage of the latter to revenge the injury is active and unbounded, and she rushes to the spot from which the attack was made with almost irresistible rapidity and fury: she moreover deplores the destruction of her cubs by sounds and gesticulation, indicating the most violent and heart-rending sorrow, folding them, though lifeless, to her bosom, attempting to recover them back to animation, and continuing by them long after the last spark of life has been extinguished in them. The fondness of the young for the parent is little less strong and impressive. These creatures are hunted by the natives of Kamtschatka with great skill, intrepidity, and success: if the bear should not instantly fall by a musket-shot, or be disabled from running, he rushes towards his antagonist animated with the completest spirit of vengeance; and, should he not in this instant be received upon the spear, which is dexterously prepared to transfix him at the critical moment, the death of the hunter is almost the certain and immediate consequence. Fatal results have not unfrequently attended the sportsmen in these conflicts. These animals have considerable sagacity, and are stated, upon respectable authority, to ascend rocks with extreme caution, to avoid the observance of a herd of bareins feeding beneath, and which, on account of the speed of the latter, they could not openly approach: from these summits, however, they will loosen and roll down large stones, and thus destroy or mutilate their prey beneath, descending afterwards to enjoy the rich reward of their stratagem and toil. The inhabitants of Kamtschatka are reported to pride themselves in imitating the movements of the bears in their dances, and to acknowledge themselves highly indebted to them for the application of various simples for wounds and diseases. The morse is one of the most formidable enemies of the bear, and generally triumphs from the advantage of its lengthened and formidable tusks. See Mammalia, Plate XXI. fig. 5.

The U. gulo, or glutton, is about three feet long, exclusively of its tail, which is one foot in length. It is met with in the northern regions of Europe and Asia. Its name is characteristically derived from its habits, as it preys with extreme voracity on almost every species of animal food, in its fresh or putrid state. It is said to lay wait in trees, and to spring on a variety of animals passing unsuspectingly beneath, and, after exhausting them by sucking their blood, to tear them in pieces and devour them. It produces from two to four young once a year. Its strength and ferocity are such, that it sometimes contends for its prey victoriously, even with the wolf or the bear. The skin of this animal is an article of commerce, and it is most esteemed as such in proportion as its colour approaches to a perfect blackness.

U. luscus, or the wolverene, is supposed to be merely a variety of the former. It has been brought into this country from Hudson's Bay, about twice the size of a fox, and was in this instance perfectly tame and inoffensive.

U. lutor, or the racoon, is a native of America and the West Indies, of a grey colour, and with a head shaped like that of a fox, and of the length of between two and three feet without the tail. Its natural food consists of fruits, young sugar-canes, and unripe maize; and also, it is thought, of eggs and poultry. It is nocturnal, and seldom quits its hole by day; and during the rigours of winter, it continues there in a state of abstinence and perhaps of torpor. It may be domesticated with great facility, and is seen in this familiar state in many houses in America. It is agile and sprightly, ascends trees with great ease, is particularly fond of vegetable sweets, and averse from acid substances, and, while taking its food, generally uses its fore feet as hands, sitting on its hind ones. It is said to have an admirable tact at opening oysters and other shell-fish, and is extremely cleanly in all its habits. Its fur is highly useful in the manufacture of hats.

U. meles, or the common badger, is about two feet from the nose to the tail, and is found in almost all the temperate regions both of Europe and Asia, living in subterranean habitations, which its feet are admirably adapted for preparing. Its food consists of fruits and roots, frogs and insects; and the resemblance of its teeth to those of beasts of prey, makes it probable that it destroys lambs and larger animals, which it is stated to do: in a domestic state it prefers raw flesh to every other species of food. It will attack bee-hives, to obtain

the honey contained in them. It sleeps much; passes the winter, or the greater part of it, in its burrowed residence, in a state of lethargy and torpor; and in summer produces, generally, three young ones at a birth. These animals are inoffensive in their manners; reluctant to attack, but well prepared by nature for defence, which they conduct with an alertness, intrepidity, and perseverance, truly admirable. To afford a spectacle of these qualities to the populace of several countries, the badger is frequently baited with dogs, which, from the looseness of the badger's skin and the coarseness of its hair, are prevented sometimes from penetrating to his flesh with their teeth, and almost always, from so fastening him by their bite as to preclude his turning in various directions for their annoyance. The strength of his jaws, and the sharpness of his teeth, enable him to deal the most painful and destructive wounds; indeed, his bite almost uniformly brings with it the flesh, as well as the blood of his antagonist. He is at length overpowered by numbers, but seldom without having inflicted a severe and fatal revenge. His agility of movement in the conflict gives a most important advantage, as his blow is as it were struck, while the enemy is only preparing for the attack. The badger is particularly cleanly in his habits; and his flesh, prepared like that of the hog, is said to be equally valuable and well-flavoured.

URTICA, in botany, *nettle*, a genus of the Monoecia Tetrandria class and order. Natural order of Scabridæ. Urticæ, Jussieu. Essential character: male, calyx four-leaved; corolla none; nectary central, cup-shaped: female, calyx two-leaved; corolla none; seed one, superior, shining. There are fifty-nine species.

URTICULARIA, in botany, *bladder-wort*, a genus of the Diandria Monogynia class and order. Natural order of Corydales. Lysimachiæ, Jussieu. Essential character: corolla ringent, spurred; calyx two-leaved, equal; capsule one-celled. There are thirteen species.

USANCE, in commerce, is a determinate time fixed for the payment of bills of exchange, reckoned either from the day of the bills being accepted, or from the day of their date; and thus called because regulated by the usage and custom of the places whereon they are drawn. See EXCHANGE.

USE, in law, is a trust and confidence reposed in another, who is tenant of the land, that he shall dispose of the land according to the intention of *cestuy que use*, or him to whose use it was granted, and suffer him to take the profits.

By statute 27, Henry VIII. c. 10. commonly called the statute of uses, or the statute for transferring uses into possession, the *cestuy que use* is considered as the real owner of the estate; whereby it is enacted, that when any person is seised of lands to the use of another, the person entitled to the use in fee-simple, fee-tail, for life or years, or otherwise, shall stand and be seised or possessed of the land, in the like estate, as he hath of the use, trust, or confidence. And thereby the act makes *cestuy que use* complete owner both at law and in equity. This is one of the most important statutes in the law respecting conveyances, and it is as it were the hinge, upon which all the system of conveyancing turns. It is extremely difficult to explain its effect in this dictionary, but it may be important to say, that in any conveyance which operates under the statute of uses, it is necessary to declare a use, as to say the estate is given to A B, to the use of A B, without which the use, that is, all the interest in the estate, results to the donor. A trust is now what a use was formerly. See TRUST.

USHER, an officer, or servant, who has the care and direction of the door of a court, hall, chamber, or the like.

In the king's houshold there are two gentlemen ushers of the privy-chamber appointed to attend the door, and give entrance to persons that have admittance thither; four gentlemen-ushers, waiters; and eight gentlemen-ushers, quarter-waiters in ordinary.

USHER also signifies an officer of the Court of Exchequer, of which there are four who attend the barons and chief officers of that court at Westminster, as also juries, sheriffs, &c. at the pleasure of the court. There is also an usher of the Court of Chancery.

USHER *of the Black Rod*, the eldest of the gentlemen-ushers daily waiters at court, whose duty is to bear the rod before the King at the feast of St. George, and other solemnities: he has also the keeping of the chapter-house door, when a chapter of the order of the garter is sitting, and in time of parliament attends the house of peers, and takes delinquents into custody. He wears a gold badge, embellished with the ensigns of the order of the garter.

USTERIA, in botany, a genus of the

Monandria Monogynia class and order. Essential character; calyx four-toothed, with one segment much larger than the rest; corolla funnel-form, four-toothed; capsule one-celled, two-seeded; seeds arilled. There is but one species, viz. U. guineensis, a native of Guinea.

USURY, in a strict sense, is a contract upon the loan of money, to give the lender a certain profit for the use of it, upon all events, whether the borrower made any advantage of it, or the lender suffered any prejudice for the want of it, or whether it be repaid at the appointed time or not; and in a large sense, it seems, that all undue advantages, taken by a lender against a borrower, come under the notion of usury.

The statute 12 Anne, c. 16, enacts that no person, upon any contract which shall be made, shall take for loan of any money, wares, &c. above the value of 5*l.* for the forbearance of 100*l.* for a year; and all bonds and assurances for the payment of any money to be lent upon usury, whereupon or whereby there shall be reserved, or taken, above five pounds in the hundred, shall be void; and every person who shall receive, by means of any corrupt bargain, loan, exchange, shift, or interest, of any wares, or other things, or by any deceitful way, for forbearing, or giving day of payment for one year, for their money or other things, above 5*l.* for 100*l.* for a year, &c. shall forfeit treble the value of the monies or other things lent.

But if a contract, which carries interest, be made in a foreign country, our courts will direct the payment of interest, according to the law of that country in which the contract was made. Thus, Irish, American, Turkish, and Indian interest have been allowed in our courts, to the amount of each 12*l.* per cent. For the moderation or exorbitance of interest depends upon local circumstances; and the refusal to enforce such contracts would put a stop to all foreign trade.

It may be considered as a general rule, that whatever is taken for interest can by no trick or contrivance be so concealed as to evade the general words of this statute. It is a question in politics whether the laws against usury are good for any thing except to afford government a monopoly in the borrowing of loans. Where advantage is taken of ignorance or distress equity would relieve in all cases. But surely it is hard to prevent men from making the fair price of the loan of money. A maximum is always injurious. The real price of interest is not well settled, and usurers are compelled to be exorbitant to indemnify themselves of extraordinary risks.

UVARIA, in botany, a genus of the Polyandria Polygynia class and order. Natural order of Coadunatæ. Anonæ, Jussieu. Essential character: calyx three-leaved; petals six; berries numerous, pendulous, four-seeded. There are eleven species.

VULGATE, a very ancient Latin translation of the bible, and the only one the church of Rome acknowledges authentic. See BIBLE. The ancient vulgate of the old testament was translated almost word for word from the Greek of the LXX. The author of the version is not known, nor so much as guessed at.

VULGATE *of the New Testament*. This the Romanists generally hold preferable to the common Greek text, in regard it is this alone, and not the Greek text, that the council of Trent had declared authentic. Accordingly that church has, as it were, adopted this edition. The priests read no other at the altar, the preachers quote no other in the pulpit, nor the divines in the schools.

VULTUR, the *vulture*, in natural history, a genus of birds of the order Accipitres. Generic character: the bill strait, hooked at the point; the head without feathers; the skin on the fore part naked; tongue bifid; neck retractile; legs and feet covered with great scales; claws large, little hooked, and very blunt. These birds are rapacious to an extreme degree, and sometimes feed in the midst of cities unterrified. It is observed that they prefer universally tainted meat to what is fresh, and seldom destroy animals when they can procure a sufficiency of carrion. Their scent is in the highest degree acute, and they are supposed to perceive the effluvia of carcases at the distance even of miles. They are found most numerous in the warmest climates, and must be regarded as a race of birds eminently useful in clearing the surface of the globe from putrid remains, which might infect the air, and produce all the ravages and mortality of pestilence. There are seventeen species, of which we shall notice the following.

V. gryphus, or the condur vulture, is found particularly in South America, an from point to point of its wings is of the width of twelve feet. The feathers of its back are of a brilliant black. Its quill feathers are more than two feet and a quarter

in length, and are half an inch in diameter.

V. harpyia, or the crested vulture, is rather larger than a turkey, and is distinguished by a crest of four feathers on its head. Its strength is extraordinary, and with a single stroke of its bill it is reported to be able to cleave down the scull of a man. It is found in Mexico and Brasil.

V. aura, or the carrion vulture, is of the same size as the last, is common both in North and South America, and feeds on carcasses and on snakes. Its odour is particularly rank. It is far from being ferocious and dangerous, may be easily reared tame, and is considered in the West Indies as highly useful in destroying reptiles, vermin, and carrion, insomuch that the killing of them is prohibited by law. They roost together at nights in considerable numbers, in the manner of rooks.

V. sagittarius, or the secretary vulture, is distinguished by the extraordinary length of its legs, and, when standing upright, is a yard high. It is found in Africa, and in the Philippine Islands. It principally lives on lizards and rats, and various species of vermin. It strikes with its feet forwards, and never the contrary. It takes up tortoises in its claws, and dashes them with great force on the ground, and will repeat this process till these animals are completely killed. For the king vulture, see Aves, Plate XIV. fig. 5.

UVULARIA, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Sarmentaceæ. Lilia, Jussieu. Essential character: corolla six-petalled, erect; nectary hollow at the base of each petal; filaments very short. There are six species.

W.

W, or w, is the twenty-first letter of our alphabet, and is composed, as its name implies, of two v's. It was not in use among the Hebrews, Greeks, or Romans, but chiefly peculiar to the northern nations, the Teutones, Saxons, Britons, &c. But still it is not used by the French, Italians, Spaniards, or Portuguese, except in proper names, and other terms borrowed from languages in which it is originally used, and even then it is sounded like the single v. This letter is of an ambiguous nature, being a consonant at the beginning of words, and a vowel at the end. It may stand before all the vowels except *u*, as *water*, *wedge*, *winter*, *wonder*: it may also follow the vowels, *a*, *e*, *o*, and unites with them into a kind of double vowel, or dipthong, as in *saw*, *few*, *cow*, &c.

WACCE, in mineralogy, a species of the clay genus, of a greenish grey colour, of various degrees of intensity; it occurs sometimes massive, sometimes vesicular, and the vesiculæ are either filled when the compound is denominated amygdaloid, or empty. It is not very heavy, and it is the characteristic of it that it falls to pieces in the open air. It belongs to the floetz trap formation; where it occurs in beds which generally lie under basalt, and above clay. It is found in veins, and generally forms the basis of amygdaloid. It frequently contains imbedded crystals of mica and basaltic hornblende, but does not, like basalt, include augite or olivine. It is found in many parts of Germany, and in Sweden. Werner considers it as intermediate between basalt and clay. When basalt contains mica, it is passing to wacce. Near Joachimstal there is an immense rent filled with wacce, in which whole trees are found imbedded.

WACHENDORFIA, in botany, a genus of the Triandria Monogynia class and order. Natural order of Ensatæ. Irides, Jussieu. Essential character: corolla six-petalled, unequal, inferior; capsule three-celled, superior. There are five species all natives of the Cape of Good Hope.

WADD, or Wadding, is a stopple of paper, hay, straw, or the like, forced into a gun upon the powder to keep it close in the chamber; or to put up close to the shot to keep it from rolling out.

WAFERS are made thus: take very fine flour, mix it with glair of eggs, isinglass, and a little yeast; mingle the materials; beat them well together, spread the batter, being made thin with gum water, on even tin

plates, and dry them in a stove; then cut them out for use. You may make them of what colour you please, by tinging the paste with brazil or vermilion for red; indigo or verditer, &c. for blue; saffron, turmeric, or gamboge, &c. for yellow.

WAFT, in naval language, a signal displayed from the stern of a ship for some particular purpose, by hoisting the ensign, furled up together into a long roll, to the head of its staff, or to the mizen-peek. It is particularly used to summon the ship's boats off from the shore.

WAGER of law is a particular mode of proceeding, whereby, in an action of debt, brought upon a simple contract between the parties, without any deed or record, the defendant may discharge himself by swearing in court, in the presence of compurgators, that he owes the plaintiff nothing, in manner and form as he has declared, and his compurgators swear, that they believe what he says is true. And this waging his law is sometimes called making his law. It being at length considered, that this waging of law offered too great a temptation to perjury, by degrees new remedies were devised, and new forms of action introduced, wherein no defendant is at liberty to wage his law, as in assumpsit and trover. Also when a new statute inflicts a penalty, and gives an action of debt to recover it, it is usual to add, in which no wager of law shall be allowed.

WAGERS. In general a wager may be considered as legal, if it be not an incitement to a breach of the peace, or to immorality, or if it do not affect the feelings or interest of a third person, or expose him to ridicule; or if it be not against sound policy. See INSURANCE, WAGER, POLICY.

WAIFS are goods which are stolen and waved by a felon in his flight from those who pursue him, which are forfeited; and though waif is generally spoken of goods stolen, yet if a man be pursued with hue and cry as a felon, and he flee and leave his own goods, these will be forfeited as goods stolen; but they are properly fugitive's goods, and not forfeited till it be found before the coroner, or otherwise of record, that he fled for the felony. See ESTRAYS.

WAIST, in ship-building, that part of a ship which is contained between the quarter-deck and forecastle, being usually a hollow space, with an ascent of several steps to either of those places. When the waist of a merchant-ship is only one or two steps of descent from the quarter-deck and forecastle, she is said to be galley-built; but when with six or seven steps she is called frigate-built.

WAISTERS, in naval affairs, people stationed in the waist in working the ship. As their business requires only strength without art or judgment, they are commonly selected from the strongest landsmen and ordinary seamen.

WAIVER, signifies the passing by of a thing, or a refusal to accept it: sometimes it is applied to an estate, or something conveyed to a man, and sometimes to plea, &c. and a waiver on disagreement as to goods and chattels, in case of a gift, will be effectual.

WAKE *of a ship*, is the smooth water astern when she is under sail. This shows the way she has gone in the sea, whereby the mariners judge what way she makes. For if the wake be right a-stern, they conclude she makes her way forwards; but if the wake be to leeward a point or two, then they conclude she falls to the leeward of her course. When one ship, giving chase to another, is got as far into the wind as she, and sails directly after her, they say, she has got into her wake. A ship is said to stay to the weather of her wake, when, in her staying, she is so quick, that she does not fall to leeward upon a tack, but that when she is tacked, her wake is to the leeward; and it is a sign she feels her helm very well, and is quick of steerage.

WALE, or WALES, in a ship, those outermost timbers in a ship's side, on which the sailors set their feet in climbing up. They are reckoned from the water, and are called her first, second, and third wale, or bend.

WALE *knot*, a round knot or knob made with three strands of a rope, so that it cannot slip, by which the tacks, top-sail sheets, and stoppers are made fast, as also some other ropes.

WALE *reared*, on board a ship, a name the seamen give to a ship, which, after she comes to her bearing, is built straight up. This way of building, though it does not look well, nor is, as the seamen term it, ship-shapen; yet it has this advantage, that a ship is thereby more roomy within board, and becomes thereby a wholesome ship at sea, especially if her bearing be well laid out.

WALES. By statute 27 Henry VIII. c. 26, and other subsequent statutes, the dominion of Wales shall be incorporated with, and part of the realm of England;

and all persons born in Wales shall enjoy all liberties and privileges as the subjects in England do. And the lands in Wales shall be inheritable after the English tenure, and not after any Welsh laws or customs; and the proceedings in all the law courts shall be in the English tongue. A session is also to be held twice a year in every county, by judges appointed by the King, to be called the Great Sessions of the several counties in Wales, in which all pleas of real and personal actions shall be held, with the same form of process, and in as ample manner, as in the Court of Common Pleas at Westminster; and writs of error shall lie from judgments therein to the Court of King's Bench at Westminster. But the ordinary original writs, or process, of the King's courts at Westminster, do not run into the principality of Wales, though process of execution does, as also all prerogative writs; as, writs of certiorari, quo minus, mandamus, and the like. Murders and felonies in any part of Wales may be tried in the next adjoining English county; the judges of assize having a concurrent jurisdiction throughout all Wales, with the justices of the grand sessions. All local matters arising in Wales, triable in the King's Bench, are, by the common law, to be tried by a jury, returned from the next adjoining county in England. No sheriff or officer in Wales shall, upon any process out of the courts at Westminster, hold any person to special bail, unless the cause of action be twenty pounds, or upwards. 11 and 12 William, c. 9.

WALL, in architecture, the principal part of a building, as serving both to inclose it, and support the roof, floors, &c. See BUILDING.

WALLENIA, in botany, so named in honour of Matthew Wallen, a genus of the Tetrandria Monogynia class and order. Essential character: calyx four-cleft, inferior; corolla tubular, four-cleft; berry one-seeded. There is but one species, viz. W. laurifolia, a tall tree growing naturally in Jamaica and Hispaniola.

WALLIS (Dr. JOHN), in biography, an eminent English mathematician, was the son of a clergyman, and born at Ashford, in Kent, November 23, 1616. After being instructed, at different schools, in grammar learning, in Latin, Greek, and Hebrew, with the rudiments of logic, music, and the French language, he was placed in Emanuel College, Cambridge. About 1640, he entered into orders, and was chosen Fellow of Queen's College. He kept his fellowship till it was vacated by his marriage, but quitted his college to be chaplain to Sir Richard Darley: after a year spent in this situation, he spent two more as chaplain to Lady Vere. While he lived in this family he cultivated the art of deciphering, which proved very useful to him on several occasions: he met with rewards and preferment from the government at home for deciphering letters for them; and it is said, that the Elector of Brandenburg sent him a gold chain and medal, for explaining for him some letters written in ciphers.

Academical studies being much interrupted by the civil wars in both the Universities, many learned men from them resorted to London, and formed assemblies there. Wallis belonged to one of these, the members of which met once a week, to discourse on philosophical matters; and this society was the rise and beginning of that which was afterwards incorporated by the name of the Royal Society, of which Wallis was one of the most early members.

The Savilian professor of geometry at Oxford being ejected by the parliamentary visitors, in 1649, Wallis was appointed to succeed him, and he opened his lectures there the same year. In 1653, he published, in Latin, a Grammar of the English Tongue, for the use of foreigners; to which was added, a tract "De Loquela seu Sonorum formatione," &c. in which he considers philosophically the formation of all sounds used in articulate speech, and shows how the organs being put into certain positions, and the breath pushed out from the lungs, the person will thus be made to speak, whether he hear himself or not. Pursuing these reflections, he was led to think it possible, that a deaf person might be taught to speak, by being directed so to apply the organs of speech, as the sound of each letter required, which children learn by imitation and frequent attempts, rather than by art.

In 1657, he collected and published his mathematical works, in two parts, entitled, "Mathesis Universalis," in quarto; and, in 1658, "Commercium Epistolicum de Questionibus quibusdam Mathematicis nuper habitum, in quarto; which was a collection of letters written by many learned men, as Lord Brounker, Sir Kenelm Digby, Fermat, Schooten, Wallis, and others.

Upon the Restoration he met with great respect; the King thinking favourably of him on account of some services he had done

both to himself and his father, Charles I. He was, therefore, confirmed in his places, also admitted one of the King's chaplains in ordinary, and appointed one of the divines empowered to revise the Book of Common Prayer. He was a very useful member of the Royal Society, and kept up a literary correspondence with many learned men.

In 1670, he published his "Mechanica; sive de Motu," quarto. In 1676, he gave an edition of "Archimedis Syracusani Arenarius et Dimensio Circuli;" and, in 1682, he published from the manuscripts, "Claudii Ptolemæi Opus Harmonicum," in Greek, with a Latin version and notes; to which he afterwards added, "Appendix de veterum Harmonica ad hodiernam comparata," &c.

In 1685, he published his "History and Practice of Algebra," in folio; a work that is full of learned and useful matter. Besides the works above mentioned, he published many others, particularly his "Arithmetic of Infinites," a book of genius and good invention, and perhaps almost his only work that is so, for he was much more distinguished for his industry and judgment, than for his genius. Also a multitude of papers in the Philosophical Transactions, in almost every volume, from the first to the twenty-fifth volume.

In 1697, the curators of the University press at Oxford thought it for the honour of the University to collect the Doctor's mathematical works, which had been printed separately, some in Latin, some in English, and published them all together in the Latin tongue, in three volumes, folio, 1699.

Dr. Wallis died at Oxford the 28th of October, 1703, in the eighty-eighth year of his age, leaving behind him one son and two daughters. We are told, that he was of a vigorous constitution, and of a mind which was strong, calm, serene, and not easily ruffled or discomposed. He speaks of himself, in his letter to Mr. Smith, in a strain which shows him to have been a very cautious and prudent man, whatever his secret opinions and attachments might be. He concludes; "It hath been my endeavour all along, to act by moderate principles, being willing, whatever side was uppermost, to promote any good design, for the true interest of religion, of learning, and of the public good."

WALRUS. See TRICHECUS.

WALTHERIA, in botany, so named in honour of Augustin Frederic Walther, Professor of Medicine at Leipsic, a genus of the Monadelphia Pentandria class and order. Natural order of Columniferæ. Tiliaceæ, Jussieu. Essential character: calyx double; outer lateral three-leaved, deciduous; petals five; style one; capsule one-celled, two-valved, one-seeded. There are six species.

WAPENTAKE (from the Saxon), the same with what we call a hundred, and more especially used in the northern counties beyond the river Trent. There have been several conjectures as to the original of the word; one of which is, that anciently musters were made of the armour and weapons of the inhabitants of every hundred; and from those that could not find sufficient pledges of their good abearing, their weapons were taken away, and given to others; whence, it is said, this word is derived.

WARD (Dr. SETH), an English prelate, chiefly famous for his knowledge in mathematics and astronomy, was the son of an attorney, and born at Buntingford, Hertfordshire, in 1617 or 1618. From hence he was removed and placed a student in Sidney College, Cambridge, in 1632. Here he applied with great vigour to his studies, particularly to the mathematics, and was chosen fellow of his college.

The civil war breaking out, Ward was involved, not a little in the consequences of it. He was ejected from his fellowship for refusing the covenant; against which he soon after joined, with several others, in drawing up that noted treatise, which was afterwards printed. Being now obliged to leave Cambridge, he resided for some time with certain friends about London, and at other times at Aldbury, in Surry, with the noted mathematician Oughtred, where he prosecuted his mathematical studies.

He had not been long in this family before the visitation of the University of Oxford began; the effect of which was, that many learned and eminent persons were turned out, and among them Mr. Greaves, the Savilian professor of astronomy. This gentleman laboured to procure Ward for his successor, whose abilities in his way were universally known and acknowledged; and effected it; Dr. Wallis succeeding to the geometry professorship at the same time. Mr. Ward then entered himself of Wadham College, for the sake of Dr. Wilkins, who was the warden; and he presently applied himself to bring the astronomy lectures, which had long been neglected and

disused, into repute again; and for this purpose he read them very constantly, never missing one reading day all the while he held the lecture.

In 1654, both the Savilian professors did their exercises, in order to proceed doctors in divinity; and when they were to be presented, Wallis claimed precedency. This occasioned a dispute; which being decided in favour of Ward, who was really the senior, Wallis went out grand compounder, and so obtained the precedency.

In 1659, Ward was chosen president of Trinity College, but was obliged at the Restoration to resign that place. He had amends made him, however, by being presented, in 1660, to the rectory of St. Laurence, Jewry. The same year he was also installed precentor of the church of Exeter. In 1661, he became Fellow of the Royal Society, and Dean of Exeter; and the year following he was advanced to the bishopric of the same church. In 1667, he was translated to the see of Salisbury; and, in 1671, was made Chancellor of the order of the Garter; an honour which he procured to be permanently annexed to the see of Salisbury, after it had been held by laymen for above one hundred and fifty years.

Dr. Ward was one of those unhappy persons who have had the misfortune to survive their senses, which happened in consequence of a fever ill cured: he lived till the Revolution, but without knowing any thing of the matter; and died in January, 1689, about seventy-one years of age. He was the author of several Latin works in astronomy and different parts of the mathematics, which were thought excellent in their day; but their use has been superseded by later improvements and the Newtonian philosophy.

WARDMOTE, a court kept in every ward in London, usually called the wardmote court: and the wardmote inquest has power every year to inquire into, and present, all defaults concerning the watch and constables not doing their duty; that engines, &c. be provided against fire; persons selling ale and beer be honest, and suffer no disorders, nor permit gaming, &c.; that they sell in lawful measures; and searches be made for vagrants, beggars, and idle persons, &c. who shall be punished.

WARE, or WEAR, in naval affairs, to cause a ship to change her course from one board to the other, by turning her stern to the wind. Hence it is used in the same sense of veering, and in opposition to tacking, in which the head is turned to the wind, and the stern to the leeward.

WARNING *piece*, in the military art, is the gun which is fired every night about sun-set, to give notice to the drums and trumpets of the army to beat and sound a retreat or tattoo, which is likewise called setting the watch.

WARNING *wheel*, in a clock, is the third or fourth, according to its distance from the first wheel.

WARP, in the manufactures, is the threads, whether of silk, wool, linen, hemp, &c. that are extended lengthwise on the weaver's loom; and across which the workman by means of his shuttle passes the threads of the woof, to form a cloth, riband, fustian, or other matter. For a woollen stuff to have the necessary qualities, it is required that the threads of the warp be of the same kind of wool, and of the same fineness throughout; that they be sized with Flanders or parchment size, well prepared, and that they be in sufficient number with regard to the breadth of the stuff to be wrought. To warp a ship, is to shift her from one place to another, when the wind and tide will permit it without danger.

WARRANT, a præcipe, under hand and seal, to some officer, to bring any offender before the person granting it; and warrants of commitment are issued by the Privy Council, a secretary of state, or justice of peace, &c. where there has been a private information, or a witness has deposed against an offender. Any one under the degree of nobility may be arrested for a misdemeanor, or any thing done against the peace of the kingdom, by warrant from a justice of the peace; though if the person be a peer of the realm, he must be apprehended for a breach of the peace by warrant out of the King's Bench.

A general warrant to apprehend all persons suspected, without naming or particularly describing any person in special, is illegal and void for its uncertainty: for it is the duty of the magistrate, and ought not to be left to the officer, to judge of the ground of the suspicion. Also a warrant to apprehend all persons guilty of such a crime is no legal warrant; for the point upon which its authority rests is a fact to be decided on a subsequent trial; namely, whether the person apprehended thereupon be guilty or not guilty. A warrant may be lawfully granted by any justice, for treason, felony, præmunire, or any offence against

the peace, and it seems clear, that where a statute gives any one justice a jurisdiction over any offence, or a power to require any person to do a certain thing ordained by such statute, it impliedly gives a power to every such justice to make out a warrant to bring before him any one accused of such offence, or compelled to do any thing ordained by such statute; for it cannot but be intended, that a statute which gives a person jurisdiction over an offence, means also to give him the power incident to all courts of compelling the party to come before him. But in cases where the King is not a party, or where no corporal punishment is appointed, as in cases for servants' wages, and the like, it seems that a summons is the more proper process; and for default of appearance the justice may proceed; and so indeed it is often directed by special statutes. A warrant from any one of the justices of the Court of King's Bench extends over all the kingdom, and is tested or dated England, but a warrant of a justice of peace in one county must be backed, that is, signed by a justice of another county, before it can be executed there: and a warrant for apprehending an English or a Scotch offender may be indorsed in the opposite kingdom, and the offender carried back to that part of the united kingdom in which the offence was committed. This is also now extended to Ireland, upon a proper certificate of an indictment or information filed in either country.

WARRANT *of attorney*, is an authority and power given by a client to his attorney to appear and plead for him; or to suffer judgment to pass against him by confessing the action, by *nil dicit, non sum informatus*, &c. and although a warrant of attorney given by a man in custody to confess a judgment, no attorney being present, is void as to the entry of judgment, yet it may be a good warrant to appear and file common bail. A warrant of attorney to confess a judgment affords the best personal security that a creditor can have, and if together with it a saleable lease is pledged, it is perhaps the best security that can be had.

WARRANTY, a promise or covenant by deed, made by the bargainer for himself and his heirs, to warrant or secure the bargainee and his heirs against all men, for the enjoying any thing agreed on between them. Warranty is either real or personal: real, when it is annexed to lands or tenements granted for life, &c. and this is either in deed, as by the words "I warrant" expressly; or in law, as by the word *dedi*, "I have given," or some other amplification. Personal, which either respects the property of the thing sold, or the quality of it. Warranties in their more general divisions are of two kinds: first, a warranty in deed, or an express warranty, which is when a fine, or feoffment in fee, or a lease for life, is made by deed, which has an express clause of warranty contained in it, as when a conusor, feoffer, or lessor, covenants to warrant the land to the conusee, feoffee, or lessee; secondly, a warranty in law, or an implied warranty, which is when it is not expressed by the party, but tacitly made and implied by the law. A warranty in deed is either lineal or collateral. A lineal warranty is a covenant real, annexed to the land by him who either was owner of or might have inherited the land, and from whom his heir lineal or collateral might possibly have claimed the land as heir from him that made the warranty. A collateral warranty is made by him that had no right, or possibility of right, to the land, and is collateral to the title of the land. On a sale of goods, the seller by implication warrants that he has a good title to them. See Insurance.

WARREN, a franchise, or place privileged either by prescription or grant from the king, to keep beasts and fowl of warren in; as rabbits, hares, partridges, pheasants, &c.

WASH, among distillers, the fermentable liquor used by the malt distillers.

WASP. See Vespa.

WASTE, is the committing any spoil or destruction in houses, lands, &c. by tenants, to the damage of the heir, or of him in reversion or remainder; whereupon the writ or action of waste is brought for the recovery of the thing wasted, and damages for the waste done. There are two kinds of waste, voluntary or actual, and negligent or permissive. Voluntary waste may be done by pulling down or prostrating houses, or cutting down timber trees: negligent waste may be, by suffering an house to be uncovered, whereby the spars or rafters, planches, or other timber of the house, are rotten, or by not properly repairing. A writ of waste, to punish the offence after it has been committed, is an action partly founded upon the common law, and partly upon the statute of Gloucester, and may be brought by him that has the immediate state of inheritance in reversion or remainder

against the tenant for life, tenant in dower, tenant by the courtesy, or tenant for years. This action of waste is a mixed action; partly real, so far as it recovers land; and partly personal, so far as it recovers damages; for it is brought for both those purposes; and if the waste be proved, the plaintiff shall recover the thing or place wasted, and also treble damages, by the said statute. 6 Edward I. c. 5. The writ of waste calls upon the tenant to appear, and show cause why he has committed waste and destruction, in the place named, to the disherison of the plaintiff. And if the defendant make default, or do not appear at the day assigned him, then the sheriff is to take with him a jury of twelve men, and go in person to the place alledged to be wasted, and there enquire of the waste done, and the damages, and make a return or report of the same to the court, upon which report the judgment is founded. The more common remedy is now by an action upon the case for damages only. A tenant at will is not liable for permissive waste, nor a tenant from year to year.

WATCH, in the art of war, a number of men posted at any passage, or a company of the guards who go on the patrol.

At sea the term watch denotes a measure or space of four hours, because half the ship's company watch, and do duty in their turns, so long at a time; and they are termed starboard watch and larboard watch.

WATCH is also used for a small portable movement or machine for the measuring of time, having its motion regulated by a spiral spring. Watches, strictly taken, are all such movements as show the parts of time; as clocks are such as publish it, by striking on a bell, &c. But, commonly, the name watch is appropriated to such as are carried in the pocket, and clock to the large movements, whether they strike or not. See CHRONOMETER, CLOCK, HOROLOGY.

The several members of the watch part are, 1. The balance, consisting of the rim, which is its circular part; and the verge, which is its spindle, to which belong the two pallets, or levers, that play in the teeth of the crown-wheel. 2. The potence, or pottance, which is the strong stud in pocket watches, whereon the lower pivot of the verge plays, and in the middle of which one pivot of the balance-wheel plays; the bottom of the potence is called the foot, the middle part the nose, and the upper part the shoulder. 3. The cock, which is the piece covering the balance. 4. The regulator, or pendulum spring, which is the small spring in new pocket watches, underneath the balance. 5. The pendulum, whose parts are the verge, pallets, cocks, and the bob. 6. The wheels, which are the crown-wheel in pocket pieces, and swing-wheel in pendulums, serving to drive the balance or pendulum. 7. The contrate-wheel, which is that next the crown-wheel, &c. and whose teeth and hoop lie contrary to those of other wheels; whence the name. 8. The great, or first wheel, which is that the fusee, &c. immediately drives: after which are the second wheel, third wheel, &c. 9. Lastly, between the frame and dial-plate is the pinion of report, which is that fixed on the arbor of the great wheel, and serves to drive the dial-wheel as that serves to carry the hand.

Plate Watch represents the parts of a watch the proper size: fig. 1 is a plan of the wheel work, the upper plate (fig. 2) being removed to expose them; fig. 2 is the upper plate, the cock, F, (fig. 5) being taken away to show the balance; fig. 3, the wheel work beneath the dial; fig. 4, a detached part; fig. 5, a general elevation of the whole, being supposed to be set out at length to show the whole at one view; fig. 6, the great wheel; fig. 7, the under side of the fusee; fig. 8, the main-spring, barrel, &c.

The essential difference between a clock and a watch consists in two particulars: first, it is moved by a spring in lieu of a weight; and, secondly, its motion is governed by a balance instead of a pendulum. The balance is a small wheel, n, (fig. 2 and 5, Plate Watch) fixed on an arbor, or axis, called the verge, and turning freely upon pivots at the ends of the arbor. To the axis of the balance the inner end of a very elastic spiral spring, o, called the pendulum spring, is fastened, and the outer end of the spiral is made fast to some fixture, r: in this state the balance will have a position of rest, which will be when the spiral spring o is in that position which it would assume when detached from the balance, and perfectly at liberty: now, if the balance is turned round on its pivots by any external force in either direction, it will wind up or unwind the spiral spring, which will (when the external force is removed) return the balance to its state of rest; and as this is done with considerable velocity, the momentum the balance acquires by its motion will carry it beyond the point of rest

on the other side; this again alters the spring, which returns the balance, throwing it beyond the point of rest; and in this manner the balance will vibrate until the friction of the pivots and the resistance of the air destroys the original impulse. All vibrations of such a balance which pass through equal spaces will be performed in equal times.

This simple apparatus is all which is required for measuring time, the other mechanism of the watch being devoted to two objects: first, to give a small impulse to the balance at each vibration, to overcome the friction and resistance of the air, and cause the balance to describe equal arcs: and, secondly, to register the number of vibrations the balance has made.

The first of these objects requires a power which shall be in constant readiness to act upon the balance. This is accomplished by the re-action of a spiral steel spring, A, (fig. 8) which when at rest and liberty assumes that position and size: it is coiled up closer, and put into a brass box, *a*, called the spring barrel; a small hook which is at the outer end of the spring being put through a hole in the side of the box, a small arbor, B, is put into the centre of the box, and the cover or lid of the box, D, is shut in: the arbor has a hook projecting from it, which enters a hole in the inner end of the spring A; its pivots project through the barrel at each side, and enter holes in the two plates E E, (fig. 5) which forms the frame of the watch; the lower pivot passes through the plate, and has a small rachet wheel, *b*, (fig. 3 and 5) fixed upon it, a click entering the teeth thereof prevents the arbor turning round; a small steel chain is hooked to the spring-barrel, *a*, (fig. 1 and 5); at one end it passes round the barrel several times, then round the fusee, *d*, and is hooked to it by its end. The fusee, *d*, is a conical piece of brass, with a spiral groove cut thereon to receive the chain: it is mounted on pivots which turn in holes, in the two plates E E, and one of the pivots, *e*, projects a considerable distance, and is cut square. Now if a key is applied to this square, and the fusee, *d*, by that means turned round so as to wind the chain upon it, the spring barrel will be turned round, and the outer end of the spring, A, being hooked to the barrel will be turned round also; as the inner end is immoveable, by being fixed to the arbor, B, the spring will be coiled up into a closer spiral than it was when at liberty, and will consequently exert a re-action upon the chain, and by that means upon the fusee, which will be turned round thereby when the key is removed. To prevent too much chain being wound upon the fusee, and by that means breaking the chain, or overstraining the spring, a contrivance called a guard is added: it is a small lever, *x* (fig. 1) moving on a stud fixed to the upper plate of the watch, and pressed downwards by a small spring, *z*: as the chain is wound upon the fusee, it rises in the spiral groove, and lifts up the lever, *x*, until it touches the upper plate; it is then in a position to intercept the edge of the spiral piece of metal seen on the top of the fusee, and thus stop it from being wound up any further.

The power of the spring is transmitted to the balance by means of several cog wheels: the first, *f*, is upon the fusee; it is shown separated from the fusee in fig. 6, having a hole through the centre to receive the arbor of the fusee, and a projecting ring upon its surface; the under surface of the fusee is shown in fig. 7, having a circular groove cut in it to receive the corresponding ring upon the great wheel, fig. 6: the inner edge of the groove is cut with teeth to form a rachet wheel; when the wheel and fusee are put together, a small click, *g*, (fig. 6) takes into the teeth of the rachet: as the fusee is turned by the key, to wind up the watch, this click slips over the sloping sides of the teeth without turning the great wheel; but when the fusee is turned the other way by the chain, the click catches the teeth of the rachet wheel, and causes the cog wheel to turn with the fusee; the great wheel, *f*, has forty-eight teeth, and turns a pinion of twelve teeth on an arbor in the centre of the watch, which carries the minute hand: a wheel, *h*, of fifty-four teeth, called the centre wheel, is fixed upon this arbor, and turns a pinion on the same arbor with the third wheel, *k*, of forty-eight teeth, which turns the pinion of the contrate wheel, *l*, of forty-eight teeth; the contrate wheel gives motion to a pinion of six teeth, and to the balance wheel, *m*, which has fifteen large teeth, which stop against two small pallets upon the arbor of the balance, or verge, *r*: these pallets are two small teeth, projecting from the verge at right angles to each other; one engages the upper side of the wheel, and the other takes the lower. By the action of the mainspring, *a*, the wheels are all turned, and the

balance wheel, *m*, if there was no obstruction, would turn with great velocity until all the chain was wound off the fusee; but one of the pallets of the verge is always engaged with one of the teeth of the wheel, suppose one of the teeth on the lower side; now, by the balance turning round to make a vibration, the pallet allows the tooth to slip off, and the wheel begins to run down by the action of the main-spring, marking the vibrations by moving the hands G H; it is, however, stopped immediately, by the next tooth at the top of the wheel meeting the upper pallet of the verge: the balance and pallet was at that time just beginning to return, and the top of the wheel moving in contrary direction to the bottom, the tooth presses against the pallet, and assists the balance to maintain the same arc in its vibration: when the balance is about to return, the upper tooth of the wheel slips off the pallet, and the lower one catches on the lower pallet, and assists the balance as before: one of the pivots of the balance wheel works in a small frame, *y*, called the pottance; the lower pivot of the verge works in the bottom of it also, and the upper pivot turns in a cock, F, screwed to the plate E, and covering the balance to defend it from injury.

The hands, G H, are moved by the central arbor which projects through the lower plate, E, (fig. 5) and receives a pinion of twelve teeth fixed on the end of a tube which fits tight upon the arbor, but will slip round easily to set the hands when the watch is wrong: the other end of the tube is square, and receives the minute hand, H, which points out the minutes on a circle of sixty upon the dial plate M M; the pinion on the tube turns a wheel, L, of forty-eight (seen in plans in fig. 3) on whose arbor is a wheel of sixteen, turning another wheel, K, of forty-eight, the arbor of which is a tube fitting on the other tube, and has the hour hand, G, fixed upon it: by this arrangement the minute hand, H, turns round twelve times for one revolution of the hour hand, G.

As the time the balance takes to perform a vibration depends upon the arc it passes through, the least increase of force in the main-spring would alter the rate of the watch; therefore the fusee is cut into a spiral, diminishing from top to bottom, as the spring draws the chain with greater force when wound up than when it is more released. The chain acts upon a shorter lever when the spring is wound up, and upon a longer when it is down, so as to regulate the unequal action of the spring to a perfectly regular force upon the wheel work.

As it will most probably happen that a watch will not always keep the same time, it is necessary to have an adjustment that may cause it to move faster or slower: this can be done by two ways, either by increasing or diminishing the force of the main-spring, *a*, which increases or diminishes the arc the balance describes; or it may be done by strengthening or weakening the pendulum spring, *o o*, which will cause the balance to move quicker or slower. The first is done by turning the rachet wheel, *b*, (fig. 5 and 3) on the end of the arbor of the main-spring, thereby winding up or letting down the spring without turning the fusee; but as this is a very coarse adjustment, it is never used but by the maker, and recourse is had to the pendulum spring, *o*, (fig. 2) which is fixed to a stud, *r*, upon the plate E, by one end, and the verge of the balance by the other: *p* is a small piece of metal, called the curb, having a notch in it to receive the spring: the acting part of the spring is from *p* to the centre; and as the curb, *p*, is moveable, the acting length can be altered: the curb is cut into teeth, and turned by a pinion, *q*, (fig. 4) which represents the piece, *s s s s s*, detached from the plate, E, and turned up: the pinion, *q*, has a small dial, divided into thirty, fixed to its arbor on the upper side of the plate, *s s*, by which it can be set so as to regulate the watch to the utmost nicety: *t t t t* (fig. 1) are four pillars by which the two plates, E E, of the watch are held together; and *t t t t* (fig. 2) represent the heads of the same pillars coming through the upper plate, and small pins put through to keep the plate down.

WATER, a transparent fluid, without colour, smell, or taste, in a very small degree compressible; when pure, not liable to spontaneous change; liquid in the common temperature of our atmosphere, assuming the solid form at 32° Fahrenheit, and the gaseous at 212°, but returning unaltered to its liquid state on resuming any degree of heat between these points, capable of dissolving a greater number of natural bodies than any other fluid whatever, especially of those known by the name of the saline; performing the most important functions in the vegetable and animal kingdoms, and entering largely into their composition as a constituent part. Water is formed of

hydrogen, combined with oxygen, in the proportion of 14.42 to 85.58. Water is assumed as the standard, or unity, in all tables of specific gravity. A cubic inch of it weighs, at thirty inches of the barometer, and 60° thermometer, 252,422 grains. Water does not enter the list of materia medica of any of the colleges, but it is so important, both as an article of diet, and as an agent in the cure of diseases, that a brief account of its varieties and properties cannot but be proper in this place. The purest natural water is melted snow, or rain, collected in the open fields. That which falls in towns, or is collected from the roofs of houses, is contaminated with soot, animal effluvia, and other impurities; although, after it has rained for some time, the quantity of these diminishes so much, that Morveau says, it may be rendered almost perfectly pure by means of a little barytic water and exposure to the atmosphere. Rain water, after it falls, either remains on the surface of the earth, or penetrates through it until it meets with some impenetrable obstruction to its progress, when it bursts out at some lower part, forming a spring or well. The water on the surface of the earth either descends along its declivities in streams, which, gradually wearing channels for themselves, combine to form rivers, which at last reach the sea; or it remains stagnant in cavities of considerable depth, forming lakes or ponds, or on nearly level ground forming marshes. Although the varieties of spring waters are exceedingly numerous, they may be divided into, 1. The soft, which are sufficiently pure to dissolve soap, and to answer the purposes of pure water in general. 2 The hard, which contain earthy salts, decompose soap, and are unfit for many purposes, both in domestic economy and in manufactures. 3. The saline, which are strongly impregnated with soluble salts. When spring waters possess any peculiar character, they are called mineral waters. See WATERS, *mineral*.

River water is in general soft, as it is formed of spring water, which by exposure becomes more pure; and running surface water, which although turbid from particles of clay suspended in it, is otherwise very pure. Lake water is similar to river water. The water of marshes, on the contrary, is exceedingly impure, and often highly fetid, from the great proportion of animal and vegetable matters constantly decaying in them.

So early as the year 1776, an experiment was made by Macquer to ascertain what would be the product of the combustion of inflammable air, or hydrogen gas. He accordingly set fire to a bottle full of it, and held a saucer over the flame, but no soot appeared upon it as he expected, for it remained quite clean, and was bedewed with drops which were found to be pure water. Various conjectures were now formed about the nature of the product of the combustion of oxygen and hydrogen gases. By some it was supposed the carbonic acid gas; by others it was conjectured it would be the sulphurous or sulphuric acid. The latter was the opinion of M. Lavoisier. Such were the experiments and opinions of the French chemists previously to the year 1781. About the beginning of that year, Mr. Warltire, a lecturer in natural philosophy, had long entertained an opinion that the combustion of hydrogen gas with atmospheric air, might determine the question, whether heat be a heavy body. Apprehensive of danger in making the experiment, he had for some time declined it, but was at last encouraged by Dr. Priestley, and accordingly prepared an apparatus for the purpose. This was a copper vessel properly fitted, and filled with atmospherical air and hydrogen gas, which was exploded by making the electric spark pass through it. A loss of weight of two grains was observed after the combustion. A similar experiment was repeated in close glass vessels, which, though clean and dry before the combustion, became immediately wet with moisture, and lined with a sooty matter. This sooty matter, Dr. Priestley afterwards supposed, proceeded from the mercury which had been employed in filling the vessel. During the same year Mr. Cavendish repeated the experiments of Mr. Warltire and Dr. Priestley. He performed them several times with atmospheric air and hydrogen gas, in a vessel which held 24,000 grains of water, and he never could perceive a loss of weight more than one-fifth of a grain, and often none at all. In all these experiments not the least sooty matter appeared in the inside of the glass. To examine the nature of the dew which appeared in the inside of the glass, he burnt 500,000 grain measures of hydrogen gas, with about two and a half times that quantity of common air; and in this combustion he obtained one hundred and thirty-five grains of water, which had neither taste nor smell, and when it was

evaporated, left no sensible sediment. It seemed to be pure water. In another experiment, he exploded, in a glass globe, 19,500 grain measures of oxygen gas, and 37,000 of hydrogen gas, by means of the electric spark. The result of the experiment was thirty grains of water, which contained a small quantity of nitric acid. The experiments of Mr. Cavendish were made in the year 1781, and they are undoubtedly conclusive with regard to the composition of water. It would appear that Mr. Watt entertained the same ideas on this subject. When he was informed by Dr. Priestley of the result of these experiments, he observes, "Let us consider what obviously happens in the deflagration of hydrogen and oxygen gases. These two kinds of air unite with violence, they become red hot, and when cooling totally disappear. When the vessel is cooled, a quantity of water is found in it equal to the weight of the air employed. The water is then the only remaining product of the process; and water, light, and heat are all the products, unless there be some other matter set free, which escapes our senses. Are we not then authorised to conclude, that water is composed of oxygen and hydrogen gases, deprived of part of their latent or elementary heat; that oxygen gas is composed of water, deprived of its hydrogen, and united to elementary heat and light; and that the latter are contained in it in a latent state, so as not to be sensible to the thermometer or to the eye. And if light be only a modification of heat, or a circumstance attending it, or a component part of the hydrogen gas, then oxygen gas is composed of water deprived of its hydrogen, and united to elementary heat." Thus it appears that Mr. Watt had a just view of the composition of water, and of the nature of the process by which its component parts pass to a liquid state from that of an elastic fluid. Towards the end of the same year, M. Lavoisier had made some experiments, the result of which surprised him; for the product of the combustion of the oxygen and hydrogen gases, instead of being sulphuric or sulphurous acid, as he expected it, was pure water. This led him to procure an apparatus, with which the experiment might be performed on a large scale, and with more accuracy and precision. Accordingly the experiments were performed on the twenty-fourth of June, 1783, in presence of several academicians, and also of Sir Charles Blagden, who was at that time in Paris. A similar experiment wa wards performed by M. Monge, w. same result; and it was repeated ag Lavoisier and Meusnier, on a scale so as to put the matter beyond a doubt. conclusion, therefore, from the whole w that water is composed of oxygen and h drogen. Water exists in three differen states; in the solid state, or state of ice, in the liquid, and in the state of vapour or steam. Its principal properties have already been detailed in treating of the effects of caloric. It assumes the solid form when it is cooled down to the temperature of 32°. In this state it increases in bulk, by which it exerts a prodigious expansive force, which is owing to the new arrangement of its particles, which assume a crystalline form, the crystals crossing each other at angles of 60° or 120°. The specific gravity of ice is less than that of water. When ice is exposed to a temperature above 32°, it absorbs caloric, which then becomes latent, and is converted into the liquid state, or that of water. At the temperature of 42½°, water has reached its maximum of density. According to the experiments of Lefevre Gineaux, a French cubic foot of distilled water, taken at its maximum of density, is equal to 70 pounds, 223 grains French, equal 529,452.9492 troy grains. An English cubic foot at the same temperature weighs 437,102.4946 grains troy. By Professor Robinson's experiments it is ascertained, that a cubic foot of water, at the temperature of 55°, weighs 998.74 avoirdupois ounces, of 437.5 grains troy each, or about 1¼ ounce less than 1000 avoirdupois ounces. When water is exposed to the temperature of 212°, it boils; and if this temperature be continued, the whole is converted into an elastic invisible fluid, called vapour or steam. This, as has been already shown, is owing to the absorption of a quantity of caloric, which is necessary to retain it in the fluid form. In this state it is about 1800 times its bulk when in the state of water. This shows what an expansive force it must exert when it is confined, and hence its application in the steam engine, of which it is the moving power.

Waters, *mineral*. The complete and accurate analysis of mineral waters is one of the most difficult subjects of chemical research, and requires a very extensive acquaintance with the properties and habitudes of a numerous class of substances. Such minuteness, however, is scarcely ever

quired in the experiments that are subservient to the ordinary purposes of life; a general knowledge of the composition of bodies being sufficient to assist in directing the most useful applications of them. Instead therefore of giving a very ample detail of all the methods pointed out by Kirwan and others, we shall describe the means which are most generally useful in researches of this kind.

Before any proceeding is made in the analysis of a water, it is proper to inquire into its natural history, and to examine attentively its physical characters. The temperature of the water must be carefully observed, and the quantity inquired into, which it yields in a given time. The sensible qualities of taste, smell, degree of transparency, &c. are also best ascertained at the fountain-head. The specific gravity of the water must also be found. See GRAVITY, *specific*.

The readiest way of judging of the contents of mineral waters are by applying tests or re-agents, the chief of which are the following:

Infusion of litmus is a test of most uncombined acids.

If the infusion redden the unboiled, but not the boiled water, we may infer, that the acid is volatile, and most probably, the carbonic. Sulphuretted hydrogen gas, dissolved in water, also reddens litmus, but not after boiling.

To ascertain whether the change be produced by carbonic acid, or by sulphuretted hydrogen, when experiment shows that the reddening cause is volatile, add barytic water. This, if carbonic acid be present, will occasion a precipitate, which will dissolve, with effervescence, on adding a little muriatic acid. Sulphuretted hydrogen may also be contained, along with carbonic acid, in the same water; which will be determined by the tests hereafter to be described. Paper tinged with litmus is also reddened by the presence of carbonic acid, but regains its blue colour on drying.

Infusion of Litmus reddened by Phosphoric Acid,—Tincture of Brazil-wood,—Tincture of Turmeric, and Paper stained with each of these three Substances,—Tincture of Red Cabbage.—All these different tests have one and the same object.

Infusion of litmus, reddened by phosphoric acid, or litmus paper reddened by it, has its blue colour restored by alkalies and earths, and by carbonated alkalies and carbonated earths. Turmeric paper and tincture are changed to a reddish-brown by alkalies, whether freed from carbonic acid or not; by earths, freed from carbonic acid, but not by carbonated earths.

The red infusion of Brazil-wood, and paper stained with it, become blue by alkalies and earths, and even by the latter, when dissolved by an excess of carbonic acid. In the last mentioned case, however, the change will either cease to appear, or will be much less remarkable when the water has been boiled.

Tincture of cabbage is, by the same causes, turned green; as is also paper stained with the juice of the violet, or with the scrapings of radishes.

Tincture of galls.—Tincture of galls is employed for discovering iron, with which it produces a black tinge. The iron, however, in order to be detected by this test, must be in the state of a red oxide, or, if oxydized in a less degree, its effects will not be apparent, unless after standing some time in contact with the air. By applying this test before and after evaporation, or boiling, we may know whether the iron be held in solution by carbonic acid, or by a fixed acid; for,

1. If it produce its effect before the application of heat, and not afterward, carbonic acid is the solvent.

2. If after, as well as before, a fixed and vulgarly called mineral acid is the solvent.

3. If, by the boiling, a yellowish powder be precipitated, and yet galls continue to strike the water black, the iron, as often happens, is dissolved both by carbonic acid gas and by a fixed acid.

Sulphuric Acid.—Sulphuric acid discovers, by a slight effervescence, the presence of carbonic acid, whether uncombined or united with alkalies or earths.

2. If lime be present, the addition of sulphuric acid occasions, after a few days, a white precipitate.

3. Barytes is precipated instantly, in the form of a white powder.

4. Nitric or muriatic salts, in a dry state, or dissolved in very little water, on adding sulphuric acid, and applying heat, are decomposed: and if a stopper, moistened with solution of ammonia, be held over the vessel, white clouds will appear. For distinguishing whether nitric or muriatic acid be the cause of this appearance, rules will be given hereafter.

Oxalic Acid and Oxalates.—This acid is a most delicate test of lime, which it separates from all its combinations.

1. If a water, which is precipitated by oxalic acid, become milky on adding a watery solution of carbonic acid, or by blowing air through it from the lungs, by means of a quill or glass tube, we may infer that lime (or barytes which has never yet been found pure in waters) is present in an uncombined state.

2. If the oxalic acid occasion a precipitate before, but not after boiling, the lime is dissolved by an excess of carbonic acid.

3. If after boiling, by a fixed acid. A considerable excess of any of the mineral acids, however, prevents the oxalic acid from occasioning a precipitate, even though lime be present; because some acids decompose the oxalic, and others, dissolving the oxalate of lime, prevent it from appearing. (Vide Kirwan on Waters, page 88).

The oxalate of ammonia, or of potash, are not liable to the above objection, and are preferable, as re-agents to the uncombined acid. Yet even these oxalates fail to detect lime when supersaturated with muriatic or nitric acids; and, if such an excess be present, it must be saturated, before adding the test, with ammonia. A precipitate will then be produced.

The quantity of lime, contained in the precipitate, may be known, by first igniting it with access of air, which converts the oxalate into a carbonate; and by expelling from this last the carbonic acid, by a strong heat, in a covered crucible. According to Dr. Marcet, 117 grains of sulphate of lime give 100 of oxalate of lime, dried at 160° Fahrenheit.

Fluate of ammonia is also a most delicate test of lime.

Barytic Water.—1. Barytic water is a very effectual test for detecting the presence of carbonic acid, with which it forms a precipitate, which is soluble with effervescence in dilute nitric, or better in muriatic acid.

2. Barytic water is also a most sensible test of sulphuric acid and its combinations, which it indicates by a precipitate not soluble in muriatic acid.

Metals.—Of the metals, silver, bismuth, and mercury, are tests of the presence of hydro-sulphurets, and of sulphuretted hydrogen gas. If a little quicksilver be put into a bottle, containing water impregnated with either of these substances, its surface soon acquires a black film, and, on shaking the bottle, a blackish powder separates from it. Silver leaf and bismuth are speedily tarnished by the same cause.

Sulphate, Nitrate, and Acetate of Silver.—These solutions are all, in some measure, applicable to the same purpose.

They are peculiarly adapted to the discovery of muriatic acid and of muriates, with which they form a white precipitate. A precipitation, however, may arise from other causes, which it may be proper to state. The solutions of silver in acids are precipitated by carbonated alkalies and earths. The agency of the alkalies and earths may be prevented, by previously saturating them with a few drops of the same acid in which the silver is dissolved. The nitrate and acetate of silver are decomposed by the sulphuric and sulphureous acids; but this may be prevented by adding, previously, a few drops of nitrate or acetate of barytes, and, after allowing the precipitate to subside, the clear liquor may be decanted, and the solution of silver added. Should a precipitate now take place, the presence of muriatic acid, or some of its combinations, may be suspected. To obviate uncertainty, whether a precipitate be owing to sulphuric or muriatic acid, a solution of sulphate of silver may be employed, which, when no uncombined alkali, or earth, is present, is affected only by the latter acid.

The solutions of silver are also precipitated by sulphuretted hydrogen, and by hydro-sulphurets; but the precipitate is then reddish, or brown, or black; or it may be at first white, and afterwards become speedily brown or black. It is soluble, in great part, in dilute nitrous acid, which is not the case if occasioned by muriatic or sulphuric acid.

The solutions of silver are precipitated by extractive matter; but in this case also the precipitate has a dark colour, and is soluble in nitrous acid.

Acetate of Lead.—Acetate of lead is a test of sulphuretted hydrogen and of hydro-sulphurets of alkalies, which occasion a black precipitate; and if a paper, on which characters are traced with a solution of acetate of lead, be held over a portion of water containing sulphuretted hydrogen gas, they are soon rendered visible, especially when the water is a little warmed.

Muriate, Nitrate, and Acetate of Barytes.—These solutions are all most delicate tests of sulphuric acid and of its combinations, with which they give a white precipitate, insoluble in dilute muriatic acid. They are decomposed, however, by carbonated alkalies; but the precipitates, occasioned by carbonates, is soluble in dilute muriatic or

nitric acid, with effervescence, and may even be prevented by adding previously a few drops of the same acid as that contained in the barytic salt, which is employed.

One hundred grains of dry sulphate of barytes contain (according to Klaproth, vol. i. p. 168.) about 45½ of sulphuric acid, of the specific gravity 1850; according to Clayfield, (Nicholson's Journal, 4to. iii. 38.) 33 of acid, of specific gravity 2240; according to Thevuard, after calcination, about 25; and according to Mr. Kirwan, after ignition, 23.5 of real acid. The same chemist states, that 170 grains of ignited sulphate of barytes denote 100 of dried sulphate of soda; while 136.36 of the same substance indicate 100 of dry sulphate of potash; and 100 parts result from the precipitation of 52.11 of sulphate of magnesia.

From Klaproth's experiments, it appears that 1000 grains of sulphate of barytes indicate 595 of desiccated sulphate of soda, or 1416 of the crystallized salt. The same chemist has shown, that 100 grains of sulphate of barytes are produced by the precipitation of 71 grains of sulphate of lime.

Prussiates of Potash and of Lime.—Of these two, the prussiate of potash is the most eligible. When pure, it does not speedily assume a blue colour, on the addition of an acid, nor does it immediately precipitate muriate of barytes.

Prussiate of potash is a very sensible test of iron, with the solutions of which in acids it produces a Prussian blue precipitate, in consequence of a double elective affinity. To render its effects more certain, however, it may be proper to add, previously, to any water suspected to contain iron, a little muriatic acid, with a view to the saturation of uncombined alkalies or earths, which, if present, prevent the detection of very minute quantities of iron.

1. If a water, after boiling and filtration, does not afford a blue precipitate, on the addition of prussiate of potash, the solvent of the iron may be inferred to be a volatile one, and probably the carbonic acid.

2. Should the precipitation ensue in the boiled water, the solvent is a fixed acid, the nature of which must be ascertained by other tests.

In using the prussiate of potash for the discovery of iron, considerable caution is necessary, in order to attain accurate results. The prussiate should, on all occasions, be previously crystallized; and the quantity of oxide of iron essential to its constitution, or at least an invariable accompaniment, should be previously ascertained in the following manner: Expose a known weight of the crystallized salt to a low red heat in a silver crucible. After fusing and boiling up, it will become dry, and will then blacken. Let it cool; wash off the soluble part; collect the rest on a filter; dry it, and again calcine it with a little wax. Let it be again weighed, and the result will show the proportion of oxide of iron present in the salt which has been examined. This varies from 22 to 30 and upwards per cent. When the test is employed for discovering iron, let a known weight of the salt be dissolved in a given quantity of water; add the solution gradually; and observe how much is expended in effecting the precipitation. Before collecting the precipitate, warm the liquid, which generally throws down a further portion of Prussian blue. Let the whole be washed and dried, and then ignited with wax. From the weight of the oxide obtained, deduct that quantity which, by the former experiment, is known to be present in the prussiate that has been added; and the remainder will denote the quantity of oxide of iron present in the liquor which is under examination.

Succinate of Soda and Succinate of Ammonia are also tests for iron.

In applying these agents, it is necessary not to use more than is sufficient for the purpose; because an excess of them re-dissolves the precipitate. The best mode of proceeding is to heat the solution containing iron, and to add gradually the solution of succinate, until it ceases to produce any effect. A brownish precipitate is obtained, consisting of succinate of iron. This, when heated with a little wax, in a low red heat, gives an oxide of iron containing about seventy per cent. of the metal.

The succinates, however, precipitate alumine, provided there be no considerable excess of acid in the aluminous salt. On magnesia they have no action, and hence they may be successfully employed in the separation of these two earths.

Phosphate of Soda.—An easy and valuable method of precipitating magnesia has been suggested by Dr. Wollaston. It is founded on the property which fully neutralized carbonate of ammonia possesses; first to dissolve the carbonate of magnesia formed, when it is added to the solution of magnesian salt. For this purpose a solution of carbonate of ammonia, prepared with a

portion of that salt which has been exposed, spread on a paper, for a few hours to the air, is to be added to the solution of the magnesian salt sufficiently concentrated; or to a water suspected to contain magnesia, after being very much reduced by evaporation. No precipitate will appear, till a solution of phosphate of soda is added, when an abundant one will fall down. Let this be dried in a temperature not exceeding 100° Fahrenheit. One hundred grains of it will indicate nineteen of magnesia, or about sixty-four of muriate of magnesia.

Muriate of Lime.—Muriate of lime is principally of use in discovering the presence of alkaline carbonates, which, though they very rarely occur, have sometimes been found in mineral waters. Of all the three alkaline carbonates, muriate of lime is a sufficient re-agent; for those salts separate from it a carbonate of lime, soluble, with effervescence, in muriatic acid.

With respect to the discrimination of the different alkalies, potash may be detected by muriate of platina. Carbonate of ammonia may be discovered by its smell; and by its precipitating a neutral salt of alumine, while it has no action apparently on magnesian salts.

To estimate the proportion of an alkaline carbonate present in any water, saturate its base with sulphuric acid, and note the weight of real acid which is required. Now 100 grains of real sulphuric acid saturate 121.48 potash, and 78.32 soda.

Analysis of Waters by Evaporation.—The reader, who may wish for rules for the complete and accurate analysis of mineral waters, will find in almost every chemical work a chapter allotted to this subject. He may consult Kirwan's "Essay on the Analysis of Mineral Waters," London, 1799.

Before evaporation, however, the gaseous products of the water must be collected, which may be done by filling with it a large glass bottle, or retort, capable of holding about fifty cubic inches, and furnished with a ground stopper and bent tube. The bottle is to be placed up to its neck in a kettle filled with brine, which must be kept boiling for an hour or two, renewing, by fresh portions of hot water, what is lost by evaporation. The disengaged gas is conveyed, by a bent tube, into a graduated jar, filled with, and inverted in, mercury, where its bulk is to be determined. On the first impression of the heat, however, the water will be expanded, and portions will continue to escape into the graduated jar till the water has obtained its maximum of temperature. This must be suffered to escape, and its quantity to be deducted from that of the water submitted to experiment.

In determining, with precision, the quantity of gas, it is necessary to attend to the state of the barometer and thermometer.

The gases most commonly found in mineral waters, are *carbonic acid; sulphuretted hydrogen; nitrogen; oxygen gas;* and, in the neighbourhood of volcanoes only, *sulphureous acid gas.*

To determine the proportion of the gases, constituting any mixture obtained from a mineral water in the foregoing manner, the following experiments may be made. If the use of re-agents has not detected the presence of sulphuretted hydrogen, and there is reason to believe, from the same evidence, that carbonic acid forms a part of the mixture, let a graduated tube be nearly filled with it over quicksilver; pass up a small portion of solution of potash, and agitate this in contact with the gas; the amount of the diminution will show how much carbonic acid has been absorbed; and, if the quantity submitted to experiment was an aliquot part of the whole gas obtained, it is easy to infer the total quantity present in the water. The unabsorbable residuum consists, most probably, of oxygen and azotic gases; and the proportion of these two is best learned by the use of Dr. Hope's eudiometer.

If sulphuretted hydrogen be present, along with carbonic acid, the separation of these two is a problem of some difficulty. Mr. Kirwan recommends, that a graduated glass vessel, completely filled with the mixture, be removed into a vessel containing nitrous acid. This instantly condenses the sulphuretted hydrogen, but not the carbonic acid gas. It seems to be a more eligible mode to condense the sulphuretted hydrogen by oxymuriatic acid gas (obtained from muriatic and hyper-oxymuriate of potash), adding the latter gas very cautiously, as long as it produces any condensation. Or, perhaps, a better plan of effecting the separation is the following, recommended by Mr. Henry: half fill a graduated phial with the mixed carbonic acid and sulphuretted hydrogen gases, and expel the rest of the water by oxymuriatic acid gas. Let the mouth of the bottle be then closed with a well ground stopper, and let the

mixture be kept twenty-four hours. Then withdraw the stopper under water, a quantity of which fluid will immediately rush in. Allow the bottle to stand half an hour without agitation. The redundant oxymuriatic acid gas will thus be absorbed; and very little of the carbonic acid will disappear. Supposing that, to ten cubic inches of the mixed gases, ten inches of oxymuriatic gas have been added, and that, after absorption, by standing over water, five inches remain, the result of this experiment shows, that the mixture consisted of equal parts of sulphuretted hydrogen and carbonic acid gases.

Whenever this complicated admixture of gases occurs, as in the Harrowgate, and in some of the Cheltenham waters, it is advisable to operate separately on two portions of gas, with the view to determine, by the one, the quantity of carbonic acid and sulphuretted hydrogen; and that of azote and oxygen by the other. In the latter instance, remove both the absorbable gases by caustic potash, and examine the remainder in the manner already directed.

Nitrogen gas sometimes occurs in mineral waters, almost in an unmixed state. When this happens, the gas will be known by the characters already described as belonging to it. Sulphureous acid gas may be detected by its peculiar smell of burning sulphur, and by its discharging the colour of an infusion of roses, which has been reddened by the smallest quantity of any acid adequate to the effect.

(*a*) The water should next be evaporated to dryness. The dry mass, when collected and accurately weighed, is to be put in a bottle, and highly rectified alcohol poured on it, to the depth of an inch. After having stood a few hours, and been occasionally shaken, pour the whole on a filter, wash it with a little more alcohol, and dry and weigh the remainder.

(*b*) To the undissolved residue add nine times its weight of cold distilled water; shake the mixture frequently; and, after some time, filter; ascertaining the loss of weight.

(*c*) Boil the residuum, for a quarter of an hour, in sometimes more than five hundred times its weight of water, and afterwards filter.

(*d*) The residue, which must be dried and weighed, is no longer soluble in water or alcohol. If it has a brown colour, denoting the presence of iron, let it be moistened with water, and exposed to the sun's rays for some weeks.

I. The solution in alcohol (*a*) may contain one or all of the following salts: muriates of lime, magnesia, or barytes, or nitrates of the same earths. Sometimes, also, the alcohol may take up sulphate of iron, in which the metal is highly oxydized, as will appear by its reddish-brown colour.

1. In order to discover the quality and quantity of the ingredients, evaporate to dryness; weigh the residuum; add above half its weight of strong sulphuric acid; and apply a moderate heat. The muriatic or nitric acid will be expelled, and will be known by the colour of their fumes; the former being white, and the latter orange-coloured.

2. To ascertain whether lime or magnesia be the basis of the salts, let the heat be continued till no more fumes arise, and let it then be raised to expel the excess of sulphuric acid. To the dry mass, add twice its weight of distilled water. This will take up the sulphate of magnesia, and leave the sulphate of lime. The two sulphates may be separately decomposed, by boiling with three or four times their weight of carbonate of potash. The carbonates of lime and magnesia, thus obtained, may be separately dissolved in muriatic acid, and evaporated. The weight of the dry salts will inform us how much of each the alcohol had taken up. Lime and magnesia may also be separated by the use of phosphate of soda.

II. The watery solution (*b*) may contain a variety of salts, the accurate separation of which from each other is a problem of considerable difficulty.

1. The analysis of this solution may be attempted by crystallization. For this purpose let one half be evaporated by a very gentle heat, not exceeding 80° or 90°. Should any crystals appear on the surface of the solution, while hot, in the form of a pellicle, let them be separated and dried on bibulous paper. These are muriate of soda, or common salt. The remaining solution, on cooling very gradually, will perhaps afford crystals distinguishable by their form and other qualities. When various salts, however, are contained in the same solution, it is extremely difficult to obtain them sufficiently distinct to ascertain their kind.

2. The nature of the saline contents must therefore be examined by tests, or reagents.

The presence of an uncombined alkali, as well as uncombined acids, will be discovered by the stained papers, and tests already pointed out. The vegetable alkali, or potash, may be distinguished from the mineral, or soda, by muriate of platina.

If neutral salts be present in the solution, we have to ascertain both the nature of the acid, and that of the base. This may be done by attention to the rules already given, for the application of tests, which it is unnecessary to repeat in this place.

III. The solution by boiling water contains scarcely any thing besides sulphate of lime.

IV. The residuum (*d*) is to be digested in distilled vinegar, which takes up magnesia and lime, but leaves, undissolved, alumine and highly oxydized iron. Evaporate the solution to dryness. If it contain acetate of lime only, a substance will be obtained which does not attract moisture from the air; if magnesia be present, the mass will deliquesce. To separate the lime from the magnesia, proceed as in I.

The residue insoluble in acetous acid, may contain alumine, iron, and silex. The two first may be dissolved by muriatic acid, from which the iron may be precipitated, first by prussiate of potash, and the alumine afterward by a fixed alkali.

WATER *ordeal*, or TRIAL, among our ancestors, was of two kinds, by hot and by cold water. Trial, or purgation, by boiling or hot water, was a way of proving crimes, by immerging the body, or the arm, in hot water, with divers religious ceremonies. In the judgment by boiling water, the accused, or he who personated the accused, was obliged to put his naked arm into a cauldron full of boiling water, and to draw out a stone thence placed at a greater or less depth, according to the quality of the crime. This done, the arm was wrapped up, and the judge set his seal on the cloth, and at the end of three days they returned to view it, when if it were found without any scald, the accused was declared innocent. The nobles or great personages purged themselves thus, by hot water, and the populace, by cold water. The trial, or purgation, by cold water, was thus: after certain prayers and other ceremonies, the accused was swaddled, or tied up, all in a pelotoon or lump, and thus cast into a river, lake, or vessel, of cold water, where if he sunk he was held criminal, if he floated, innocent.

WATER *bailiff*, is an officer in sea-port towns, appointed for the searching of ships; and in London, the water bailiff hath the supervising and search of fish, brought thither; and the gathering of the toll arising from the Thames; his office is likewise to arrest men for debt, &c. or other personal or criminal matters upon the river Thames.

WATER *spout*, an extraordinary meteor, most frequently observed at sea. It generally begins by a cloud, which appears very small, and which is called by the sailors the squall: this augments in a little time into an enormous cloud of a cylindrical form, or that of a cone on its apex, and produces a noise like the roaring of an agitated sea, sometimes accompanied with thunder and lightning, and also large quantities of rain or hail, sufficient to inundate large vessels, and carry away in their course; when they occur by land, trees, houses, and every thing that opposes their impetuosity. Sailors, dreading the fatal consequences of water spouts, endeavour to dissipate them by firing a cannon into them just before they approach the ship. We shall give an account of one as described by M. Tournefort, in his Voyage to the Levant.

"The first of these," says this traveller, "that we saw, was about a musquet-shot from our ship. There we perceived the water began to boil, and to rise about a foot above its level. The water was agitated and whitish; and above its surface there seemed to stand a smoke, such as might be imagined to come from wet straw before it begins to blaze. It made a sort of a murmuring sound, like that of a torrent heard at a distance, mixed, at the same time, with a hissing noise, like that of a serpent: shortly after we perceived a column of this smoke rise up to the clouds, at the same time whirling about with great rapidity. It appeared to be as thick as one's finger; and the former sound still continued. When this disappeared, after lasting for about eight minutes, upon turning to the opposite quarter of the sky, we perceived another, which began in the manner of the former; presently after a third appeared in the west; and instantly beside it still another arose. The most distant of these three could not be above a musket-shot from the ship. They all continued like so many heaps of wet straw set on fire, that continued to smoke, and to make the same noise as before. We soon after perceived each, with

its respective canal, mounting up in the clouds; and spreading, where it touched the cloud, like the mouth of a trumpet; making a figure, to express it intelligibly, as if the tail of an animal was pulled at one end by a weight. These canals were of a whitish colour, and so tinged, as I suppose, by the water which was contained in them; for, previous to this, they were apparently empty, and of the colour of transparent glass. These canals were not straight, but bent in some parts, and far from being perpendicular, but rising in their clouds with a very inclined ascent. But what is very particular, the cloud to which one of them was pointed happening to be driven by the wind, the spout still continued to follow its motion without being broken; and passing behind one of the others, the spouts crossed each other, in the form of a St. Andrew's cross. In the beginning they were all about as thick as one's finger, except at the top, where they were broader, and two of them disappeared; but shortly after the last of the three increased considerably, and its canal, which was at first so small, soon became as thick as a man's arm, then as his leg, and at last thicker than his whole body. We saw distinctly, through this transparent body, the water, which rose up with a kind of spiral motion; and it sometimes diminished a little of its thickness, and again resumed the same; sometimes widening at top, and sometimes at bottom; exactly resembling a gut filled with water, pressed with the fingers, to make the fluid rise or fall; and I am well convinced that this alteration in the spout was caused by the wind, which pressed the cloud, and compelled it to give up its contents. After some time its bulk was so diminished as to be no thicker than a man's arm again, and thus swelling and diminishing, it at last became very small. In the end, I observed the sea which was raised about it to resume its level by degrees, and the end of the canal that touched it to become as small as if it had been tied round with a cord; and this continued till the light, striking through the cloud, took away the view. I still, however, continued to look, expecting that its parts would join again, as I had before seen in one of the others, in which the spout was more than once broken, and yet again came together; but I was disappointed, for the spout appeared no more."

In the Philosophical Transactions we have descriptions of several; their effects, in some instances, are probably much exaggerated. One at Topsham is said to have cut down an apple-tree, several inches in diameter: another, we are told, seemed to be produced by a concourse of winds, turning like a screw, the clouds dropping down into it: it threw trees and branches about with a gyratory motion. See Philosophical Transactions, vol. xxii. and xxiii. One in Deeping Fen, Lincolnshire, was first seen moving across the land and water of the fen: it raised the dust, broke some gates, and destroyed a field of turnips: it vanished with an appearance of fire. Dr. Franklin supposes that a vacuum is made by the rotatory motion of the ascending air, as when water is running through a funnel, and that the water of the sea is thus raised. But Dr. Young says, no such cause could do more than produce a slight rarefaction of the air, much less raise the water to the height of thirty or forty feet, or more.

Professor Wolke describes a water spout which passed immediately over the ship in which he was sailing, in the Gulph of Finland; it appeared to be twenty-five feet in diameter, consisting of drops about the size of cherries. The sea was agitated round its base, through a space of about one hundred and thirty feet in diameter. One of the latest accounts of the phenomenon of a water-spout is that read to the Royal Society in the year 1803, from a letter written to Sir Joseph Banks, by Captain Ricketts, of the royal navy:

"In the month of July, 1800, Captain Ricketts was called on deck, on account of the rapid approach of a water-spout, among the Lipari islands. It had the appearance of a viscid fluid, tapering in its descent, proceeding from the cloud to join the sea. It moved at the rate of about two miles an hour, with a loud sound of rain. It passed the stern of the ship, and wetted the after-part of the main-sail: hence it was inferred, that water-spouts are not continuous columns of water; and subsequent observations confirmed the opinion. In November, 1801, about twenty miles from Trieste, a water-spout was seen eight miles to the south; round its lower extremity was a mist, about twelve feet high, somewhat of the form of an Ionian capital, with very large volutes, the spout resting obliquely on its crown. At some distance from this spout the sea began to be agitated, and a mist rose to the height of about four feet: then a projection descended from the black cloud that was impending, and met the ascending mist about twenty feet above the

sea: the last ten yards of the distance were described with very great rapidity. A cloud of a light colour appeared to ascend in this spout something like quicksilver in a tube. The first spout then snapped at about one-third of its height, the inferior part subsiding gradually, and the superior curling upwards. Several other projections from the cloud appeared, with corresponding agitations of the water below, but not always in spots vertically under them: seven spouts in all were formed; two other projections were re-absorbed. Some of the spouts were not only oblique but curved: the ascending cloud moved most rapidly in those which were vertical: they lasted from three to five minutes, and their dissipation was attended by no fall of rain.

WAVE, in physics, a volume of water elevated by the action of the wind, &c. upon its surface, into a state of fluctuation, and accompanied by a cavity. The extent from the bottom or lowest point of one cavity, and across the elevation, to the bottom of the next cavity, is the breadth of the wave. Waves are considered as of two kinds, which may be distinguished from one another by the names of natural and accidental waves. The natural waves are those which are regularly proportioned in size to the strength of the wind which produces them. The accidental waves are those occasioned by the wind's reacting upon itself by repercussion from hills or high shores, and by the dashing of the waves themselves, otherwise of the natural kind, against rocks and shoals; by which means these waves acquire an elevation much above what they can have in their natural state.

Mr. Boyle proved, by numerous experiments, that the most violent wind never penetrates deeper than six feet into the water; and it seems a natural consequence of this, that the water moved by it can only be elevated to the same height of six feet from the level of the surface in a calm; and these six feet of elevation being added to the six of excavation, in the part from whence that water so elevated was raised, should give twelve feet for the utmost elevation of a wave. This is a calculation that does great honour to its author; as many experiments and observations have proved that it is very nearly true in deep seas, where the waves are purely natural, and have no accidental causes to render them larger than their just proportion.

It is not to be understood, however, that no wave of the sea can rise more than six feet above its natural level in open and deep water; for waves vastly higher than these are formed in violent tempests in the great seas. These however are not to be accounted waves in their natural state, but as compound waves formed by the union of many others; for in these wide plains of water, when one wave is raised by the wind, and would elevate itself up to the exact height of six feet, and no more, the motion of the water is so great, and the succession of waves so quick, that while this is rising, it receives into it several other waves, each of which would have been at the same height with itself; these run into the first wave one after another, as it is rising; by which means its rise is continued much longer than it naturally would have been, and it becomes accumulated to an enormous size. A number of these complicated waves rising together, and being continued in a long succession by the continuation of the storm, make the waves so dangerous to ships, which the sailors in their phrase call mountains high.

"The Motion of the Waves," makes an article in the Newtonian philosophy; the author having explained their motions, and calculated their velocity from mathematical principles, similar to the motion of a pendulum, and to the reciprocation of water in the two legs of a bent and inverted syphon or tube. See PRINCIPIA.

"Stilling Waves by means of Oil." This wonderful property, though well known to the ancients, as appears from the writings of Pliny, was for many ages either quite unnoticed, or treated as fabulous by succeeding philosophers. By means of Dr. Franklin, the subject again attracted the attention of the learned; though it appears, from some anecdotes, that seafaring people have always been acquainted with it. Mr. Pennant, in his British Zoology, vol. iv. under the article Seal, takes notice, that when these animals are devouring a very oily fish, which they always do under water, the waves above are remarkably smooth; and by this mark the fishermen know where to find them. Sir Gilbert Lawson, who served long in the army at Gibraltar, assured Dr. Franklin, that the fishermen in that place are accustomed to pour a little oil on the sea, in order to still its motion, that they may be enabled to see the oysters lying at its bottom, which are there very

large, and which they take up with a proper instrument. A similar practice obtains among fishermen in various other parts, and Dr. Franklin was informed by an old sea-captain, that the fishermen of Lisbon, when about to return into the river, if they saw too great a surf upon the bar, would empty a bottle or two of oil into the sea, which would suppress the breakers, and allow them to pass freely.

The Doctor having revolved in his mind all these pieces of information, became impatient to try the experiment himself. At last having an opportunity of observing a large pond very rough with the wind, he dropped a small quantity of oil upon it. But having at first applied it on the lee-side, the oil was driven back again upon the shore. He then went to the windward side, and poured on about a tea-spoon full of oil; this produced an instant calm over a space several yards square, which spread amazingly, and extended itself gradually till it came to the lee-side; making all that quarter of the pond, perhaps half an acre, as smooth as glass. This experiment was often repeated in different places, and always with success.

WAVED, Wavy, or Wavey, in heraldry, is said of a bordure, or any ordinary, or charge, in a coat of arms, having its outlines indented, in manner of the rising and falling of waves: it is used to denote, that the first of the family in whose arms it stands, acquired its honours for sea-service.

WAX. There are two or three substances which resemble each other so closely as to have received the name of wax. The first, and by far the most important, is bees' wax, which is consumed in such vast quantities for giving light; and is also used for a variety of other purposes. Another kind of wax is the myrtle wax, which is extracted pretty largely in Louisiana, and some other parts of America, from the myrica cerifera. Another substance very similar to wax is the pe la of the Chinese, the product of an insect, the exact species of which is not known; and the white matter which yields the laccic acid has also a strong resemblance to wax. The properties which all these substances have in common are, fusibility at a moderate heat; when kindled, burning with much flame; insolubility in water, solubility in alkalies, and also in alcohol and ether. In these two latter properties all the species of wax differ from the concrete oils, with which, in other respects, they have a very strong resemblance. Bees' wax is the substance, excreted from the body of the bee, of which these insects construct their cells, both those for containing honey and for the lodgment of their young. It is collected for the use of man wherever bees are kept. A young hive will yield at the end of the season about a pound of wax; and an old hive about twice as much. The colour of wax, when fresh from the bee, is nearly white, but it soon grows considerably yellow in the hive, or if very old is of a dark brown. The wax which is the ordinary bees' wax of the shops, is a pale yellow substance, of an agreeable honey-like smell, soft, and somewhat unctuous to the touch, but without sticking to the fingers, in winter becoming considerably hard and tough, and melting at about 142°. This yellow colour and the smell of wax are entirely taken away by exposing it, when divided into thin laminæ, to the united action of the light and air, and by this means it becomes perfectly white, scentless, somewhat harder and less greasy to the touch, and in this state it is employed for candles and many other purposes. Bleached wax burns with a very pure white light, and gives no offensive smell, and very little smoke compared with tallow. Being less fusible than tallow it requires a smaller wick. Bleached wax melts at about 155° or 7° higher than the unbleached. Its specific gravity is less than that of water, being about .96. Alcohol has no sensible action on wax when cold, but on boiling it dissolves rather less than 1-20th of its weight of wax, the greater part of which separates when cold in the form of white flocculi, and what remains in solution is entirely precipitated by water. Wax is soluble abundantly in the fixed oils; but very sparingly in the essential oils. It is usually supposed that the wax is the pollen of flowers, which the bees visibly collect on their thighs, and afterwards elaborate in some unknown way. The great difference between wax and this matter which the bees collect, has however been long remarked. When examined by the microscope, this little mass of pollen is obviously composed of a number of hard grains compressed together, and if it is laid on a hot plate, it does not melt as wax would do, but smokes, dries, and is reduced to a coal, and if kindled it burns without melting. Some late very curious experiments of Huber, one of the most celebrated apiarists in

Europe, has further shown that the pollen has no share whatever in the formation of wax, but that this latter substance is produced indiscriminately from honey, sugar, or any other saccharine matter which serves as food for the bees.

WAY, a passage or road. The Roman ways are divided into consular, prætorian, military, and public; and of these we have four remarkable ones in England: the first, Watling-street, or Watheling-street, leading from Dover to London, Dunstable, Towcester, Atterston, and the Severn, extending as far as Anglesea in Wales. The second, called Hikenild, or Ikenild-street, stretches from Southampton over the river Isis, at Newbridge; thence by Camden and Lichfield; then passes the Derwent, near Derby, and ends at Tinmouth. The third, called Fosse-way, because in some places it was never perfected; but lies as a large ditch, leads from Cornwall through Devonshire, by Tethbury, near Stow in the Wolds; and beside Coventry to Leicester, Newark, and so to Lincoln. The fourth, called Erming, or Erminage-street, extends from St. David's, in Wales, to Southampton.

WAY, in law. A way may be by prescription, as, if the owners and occupiers of such a farm have immemorially used to cross another's ground; for this immemorial usage implies an original grant. A right of way may also arise by act and operation of law; for if a man grant to another a piece of ground in the middle of his field, he at the same time tacitly gives him a way to come at it; for where the law gives any thing to any person, it gives implied whatever is necessary for enjoying the same.

WAY, *milky*. See GALAXY.

WAY *of a ship*, is sometimes the same as her rake, or run forward or backward: but this term is most commonly understood of her sailing. Thus when she goes apace, it is said, that she hath a good way, or makes a fresh way. So when an account is kept how fast she sails by the log, it is called keeping an account of her way; and because most ships are apt to fall a little to leeward of their true course, they always, in casting up the log board, allow something for her leeward way.

WAY *of the rounds*, in fortification, is a space left for the passage of the rounds between the rampart and the wall of a fortified town. This is not now much in use; because the parapet, not being above a foot thick, is soon overthrown by the enemy's cannon.

WEATHER, *rules for judging of*. 1. The rising of the mercury presages, in general, fair weather; and its falling foul weather, as rain, snow, high winds, and storms. When the surface of the mercury is convex, or stands higher in the middle than at the sides, it is a sign the mercury is then in a rising state; but if the surface be concave or hollow in the middle, it is then sinking. 2. In very hot weather, the falling of the mercury indicates thunder. 3. In winter, the rising presages frost; and in frosty weather, if the mercury falls three or four divisions, there will be a thaw; but, in a continued frost, if the mercury rises, it will certainly snow. 4. When foul weather happens soon after the depression of the mercury, expect but little of it; on the contrary, expect but little fair weather when it proves fair shortly after the mercury has risen. 5. In foul weather, when the mercury rises much and high, and so continues for two or three days before the bad weather is entirely over, then a continuance of fair weather may be expected. 6. In fair weather, when the mercury falls much and low, and thus continues for two or three days before the rain comes, then a deal of wet may be expected, and probably high winds. 7. The unsettled motion of the mercury denotes unsettled weather. 8. The words engraved on the scale are not so much to be attended to, as the rising and falling of the mercury; for, if it stand at much rain, and then rises to changeable, it denotes fair weather, though not to continue so long as if the mercury had risen higher. If the mercury stands at fair, and falls to changeable, bad weather may be expected. 9. In winter, spring, and autumn, the sudden falling of the mercury, and that for a large space, denotes high winds and storms; but in summer it presages heavy showers, and often thunder. It always sinks lowest of all for great winds, though not accompanied with rain; but it falls more for wind and rain together, than for either of them alone. 10. If after rain the wind change into any part of the north, with a clear and dry sky, and the mercury rise, it is a certain sign of fair weather. 11. After very great storms of wind, when the mercury has been low, it commonly rises again very fast. In settled fair weather, except the barometer sink much, expect but little rain. In a wet season, the smallest depressions must be attended to; for when the air is much inclined to showers, a little sinking in the barometer de-

notes more rain. And in such a season, if it rise suddenly fast and high, fair weather cannot be expected to last more than a day or two. 12. The greatest heights of the mercury are found upon easterly and north easterly winds and it may often rain or snow, the wind being in these points, while the barometer is in a rising state, the effects of the wind counteracting. But the mercury sinks for wind as well as rain, in all other points of the compass.

WEAVING, the art of making threads into cloth. This art is of very ancient origin. The fabulous story of Penelope's web, and, still more, the frequent allusions to this art in the sacred writings, tend to show, that the constructing of cloth from threads, hair, &c. is a very ancient invention. It has, however, like other useful arts, undergone an infinite variety of improvements, both as to the materials of which cloth is made, the apparatus necessary in its construction, and the particular modes of operation by the artist. Weaving, when reduced to its original principle, is nothing more than the insertion of the weft into the web, by forming sheds; but this principle has been so extensively applied in almost every country, and the knowledge of its various branches has been derived from such a variety of sources, that no one person could ever be practically employed in all its branches, and though every part bears a strong analogy to the rest, yet a minute knowledge of each of these parts, can only be acquired by experience and reflection. We will, however, endeavour to give the reader as comprehensive an idea of the history and progress of this ancient and invaluable art as the nature of the thing, and the limits to which we are necessarily confined, will permit.

The history of this art is very little known, and its great antiquity necessarily involves the earlier æras of it in the most perfect obscurity. Enough, however, is known, to prove that none of the species of it originated in Britain. The silk manufacture was first practised in China, and the cotton in India. Both the woollen and linen were borrowed from the continent of Europe, and all improvements in them, in this country, were first introduced by foreign artificers who settled amongst us. To the present day, our superiority in point of quality is only universally acknowledged in the cotton manufacture; whilst in those of silk, woollen, and linen, it is still disputed by other countries. But it should be understood, that we are here speaking more particularly of the art in its more advanced and improved state. For, when it is considered, that as the wants of mankind are nearly the same in all countries, it is not improbable that the same arts, however varied in their operations, may have been invented in different countries. It is not, however, certain, that the art of making cloth is one which the Britons invented. It is more probable, that the Gauls learned it from the Greeks, and communicated the knowledge of it to the people of Britain. And it is certain, that the inhabitants of the southern parts of Britain were well acquainted with the arts of dressing, spinning, and weaving, both flax and wool, when they were invaded by the Romans.

The art of making linen, which was probably the first species of cloth invented, was communicated by the Egyptians, the inhabitants of Palestine, and other eastern nations, to the Europeans. By slow degrees it found its way into Italy, and it afterwards prevailed in Spain, Gaul, Germany, and Britain. The Belgæ manufactured linen on the continent, and when they afterwards settled in this island, it is probable they continued the practice, and taught it to the people among whom they resided.

Whatever knowledge the Britons might possess of the clothing arts, prior to the invasion, it is very certain, that these arts were much improved amongst them after that event. It appears, from the Notitia Imperii, that there was an imperial manufactory of woollen and linen cloth, for the use of the Roman army then in Britain, established at Venta Belgarum, now called Winchester.

In Bishop Aldhelm's book, concerning "Virginity," written about A. D. 680, it is remarked, "that chastity alone forms not a perfect character, but requires to be accompanied and beautified by other virtues." This observation is illustrated by the following simile, borrowed from the art of figure-weaving; "It is not a web of one uniform colour and texture, without any variety of figures, that pleaseth the eye, and appears beautiful, but one that is woven by shuttles, filled with threads of purple, and many other colours, flying from side to side, and forming a variety of figures and images, in different compartments, with admirable art." Perhaps the most curious specimen of this ancient figure-weaving and embroidery, now to be found, is that pre-

served in the cathedral of Bayeux. It is a piece of linen, about 19 inches in breadth, and 67 yards in length, and contains the history of the conquest of England by William of Normandy, beginning with Harold's embassy, A. D. 1065, and ending with his death, at the battle of Hastings, A. D. 1066. This curious work is supposed to have been executed by Matilda, wife to William, Duke of Normandy, afterwards King of England, and the ladies of her court.

Although it is certain that the art of figure-weaving was then known in Britain, it must be owned, that the piece of tapestry just mentioned owes most of its beauty to the exquisite needle-work with which it is adorned.

About the close of the eleventh century, the clothing arts had acquired a considerable degree of improvement in this island. About that time, the weavers in all the great towns were formed into guilds or corporations, and had various privileges bestowed upon them by royal charters. In the reign of Richard I. the woollen manufacture became the subject of legislation, and a law was made, A. D. 1197, for regulating the fabrication and sale of cloth. The number of weavers, however, was comparatively small, until the policy of the wise and liberal Edward III. encouraged the art, by the most advantageous offers of reward and encouragement to foreign cloth-workers and weavers who would come and settle in England. In the year 1331, two weavers came from Brabant, and settled at York. The superior skill and dexterity of these men, who communicated their knowledge to others, soon manifested itself in the improvement and spread of the art of weaving in this island.

Many weavers from Flanders were driven into England by the cruel persecutions of the Duke D'Alva, in the year 1567, who settled in different parts of the kingdom, and introduced, or promoted, the manufacture of baizes, serges, crapes, and other stuffs.

About the year 1686, nearly 50,000 manufacturers, of various descriptions, took refuge in Britain, in consequence of the revocation of the edict of Nantz, and other acts of religious persecution committed by Louis XIV. These improvements, &c. chiefly related to linen weaving.

The arts of spinning, throwing, and weaving silk, were brought into England about the middle of the fifteenth century, and were practised by a company of women in London, called silk-women. About A. D. 1480, men began to engage in the silk manufacture, and the art of silk-weaving, in England, soon arrived at very great perfection.

The civil dissentions which followed this period, retarded the progress of this art; but afterwards, when the nation was at rest, the arts of peace, and, among others, that of weaving, made rapid advances in almost every part of the kingdom. It has been generally supposed, that silk-weaving, particularly that of figure-weaving, has never been brought to that perfection in England, to which it has attained in other countries. Our silk weavers, however, seem at length determined to remove this reproach. For this purpose a most magnificent undertaking is at this time begun by the weavers in Spitalfields, London, the object of which is "to remove those prejudices which have long prevailed in favour of foreign manufactures." This object is intended to be accomplished by the "weaving of certain flags, for public exhibition, on which are to appear figures, flowers, and other devices," interwoven with various coloured silks.

After considerable labour and expense, this design is now begun to be put into execution, under the superintendance of a committee, who are appointed to receive subscriptions, and conduct the execution of the plans, &c. Mr. William Titford, of Union-street, Bishopsgate, has been appointed treasurer by the committee, and the undertaking is now making advances towards its final accomplishment. The weaving of the first flag is begun, and about twelve or fourteen inches of it completed. The designs for this flag are curious and well executed. They represent, within a large oval, "a female figure, with a dejected aspect, reclining on a remnant of brocade." Two figures, representing Enterprise and Genius, appear to encourage the dejected female. In the back ground is the Temple of Fame, on the top of which is a flag bearing the weavers' arms, to which Genius is directing the attention of the reclining figure. The four corners of this design, which are intended to be correctly engraved, are ornamented with appropriate emblematical figures of Peace, Industry, &c. It is two yards wide; and the figures in the body of the design are drawn nearly as large as life; but the silks, being all dyed fast colours, have not that brilliant appearance, in the work, which could have been wished. What makes this piece of work more curious, and will con-

vey an extraordinary stability to its texture, is, that it has a satin ground, and is brocaded on both sides exactly alike. The threads of the web, or porry, are upwards of 48,900, the lead attached to the harness weighs upwards of 500 pounds, and the shuttles, constantly in use, amount to upwards of 500. Two men are employed in the weaving, who are able to make, upon an average, about three quarters of an inch daily.

The expense of this stupendous undertaking, with respect to the first flag only, will be not less than one thousand guineas. The admirers of art, and the friends of our national manufactures, will not think this information trifling or unnecessary; the correctness of which the writer of this article has been at considerable pains to ascertain: nor ought we to omit to mention, that the idea, and much of the design, of this piece of figure-work, originated principally with Mr. Samuel Sholl, an ingenious silk-weaver, to whom the Society of Arts, a few years ago, gave a silver medal and thirty guineas, for the construction of an improved loom for weaving slight silks. For some account of the silk manufacture, see the article SILK.

The art of cotton-weaving, in its present improved state, has not been long known either in this or any other country. Wherever it originated, it is certain that most of our manufactures, in this respect, are unequalled in any part of the known world; and were it not for the many commercial restrictions, by which the present war is so unfortunately distinguished, there is every rational prospect that our cotton trade would be still further improved and extended.

Having briefly traced the history of this art in Great Britain, we proceed to a description of the manner in which it is practised in this country; confining our observations chiefly to the art of cotton weaving.

The apparatus necessary in the art of cloth-weaving consists, chiefly, in the loom, shuttle, reed, and heddles, or harness, the form and use of which are here described.

There are several kinds of looms for cloth-weaving, the most common of which is that delineated on Plate Loom, (fig. 1 and 2) which represents the common silk-loom. In this plate, A, (fig. 1) is the yarn-beam; B, the cloth-beam, or breast roll; D E, the treddles; *d d*, *e e*, the heddles, or harness; G, the lay, or batten; M, the seat-board; and T T, the rods. Fig. 2 is a view of the lay, or batten and reed; which, to show the reed more distinctly, is represented without the lay cape, being a long piece of wood, having a groove running along its lowermost side, for the purpose of sustaining the upper edge of the reed. The lay-cape is that part of the machine on the middle of which the weaver lays hold with his left hand when in the act of weaving. F, the lay-pole; G G, the lay-swords; H, the shuttle-race; I I, the boxes which receive the shuttles; *k k*, the peckers; *g*, the pecking-peg, or handle, and R, the reed.

When the weaver has received his warp from the warping-mill (for an account of which see MANUFACTURE *of Cotton*), his first care is to wind it upon the beam in a proper manner. Having ascertained the number of half-gangs, or beers, and the breadth of the web, he passes a small shaft of wood through the interval formed by the last of the lower pins upon the warping-mill, and a small cord tied to this shaft through that formed by the first. This gives him the lease for beaming, and keeps the half-gangs distinct. When this has been done, and the cord made fast at both ends of the shaft, the knotting left by the warper is cut, and the warp stretched to its proper breadth. An instrument, or utensil, called a ravel, is then to be used. Ravels are somewhat like reeds, and are also of different dimensions. One proper for the purpose being found, every half-gang is placed in an interval between two of the pins. The upper part, or cape, is then put on and secured, and the operation of winding the warp upon the beam commences. In broad works, two persons are employed to hold the ravel which serves to guide the warp, and to spread it regularly upon the beam; one or two to keep the chain, or chains, of the warp, at a proper degree of tension, and one or more to turn the beam upon its centres. The warp being regularly wound upon the beam, the weaver prepares to take it through the heddles, and this operation is called drawing.

Before the operation of drawing commences, two rods are inserted into the lease formed by the upper lease-pins on the warping-mill; the ends of these rods are tied together, the twine by which the lease was secured is cut away, and the warp stretched to its proper breadth. The beam is then suspended by cords behind the heddles and somewhat higher, the warp hanging down perpendicularly. The weaver then places himself in front of the heddles, and another

person is placed behind. The former opens every heddle in succession, and it is the business of the latter to select every thread in its order, and deliver it to be drawn through the open heddle. The succession in which the threads are to be delivered is easily ascertained by the rods, as every thread crosses that next to it. The warp, after passing through the heddles, is next drawn through the reed by an instrument called a sley or reed-hook, two or more threads being taken through every interval.

These operations being finished, the cords or mounting which move the heddles are applied; the reed is placed in the lay, or batten, and the warp is divided into small portions, which are tied to a shaft connected by cords to the cloth-beam.

When the weaver has finished these two operations of beaming and drawing, he proceeds to dress his warp. And here it should be remarked, that the operation of dressing applies principally to cotton. The same practice, when used upon silk, has a very destructive tendency; which is that of injuring the colours of the silk; and when used, as it sometimes very improperly is, by weavers of white satin, the injury done to the work is irreparable. In cotton, the operation of dressing is indispensable; in silk, this is by no means the case.

Dressing is justly esteemed of the first importance, in the art of weaving warps spun from flax or cotton; for it is impossible to produce work of a good quality, unless care be used in dressing the warp.

The use of dressing is, to give to yarn sufficient strength or tenacity, to enable it to bear the operation of weaving into cloth. It also, by laying smoothly all the ends of the fibres, which compose the raw material, from which the yarn is spun, tends both to diminish the friction during the process, and to render the cloth smooth, and glossy, when finished. The substance in common use for dressing, is simply a mucilage of vegetable matter boiled to a consistency in water. Wheat flour, and sometimes potatoes, are the substances commonly employed. These answer sufficiently well in giving to the yarn both the smoothness and tenacity required; but the great objection to them is, that they are too easily and rapidly affected by the operation of the atmosphere. When dressed yarn is allowed to stand exposed to the air, for any considerable portion of time, before being woven into cloth, it always becomes hard, brittle, and comparatively inflexible. It is then tedious and troublesome to weave, and the cloth is rough, wiry, and uneven. This effect is chiefly remarked in dry weather, when the weavers of fine cloth find it indispensably necessary to have their yarn wrought up, as speedily as possible, after being dressed. To counteract this inconveniency, herring or beef brine, and other saline substances, which have a tendency to attract moisture, are sometimes mixed in small quantities with the dressing: but this has not proved completely and generally successful; probably, because the proportions have not been sufficiently attended to, and because a superabundance of moisture is equally prejudicial with a deficiency. Indeed, the variation of the moisture of the air is so great and so frequent, that it has hitherto been impossible to fix any universal rule for the quantity to be mixed.

It is stated as a fact, which will appear singular to weavers in this country, that in India the process of weaving, even their finest muslins, is conducted in the open air, and exposed to all the heat of the climate, which is intense. (See MANUFACTURE *of Cotton*) We know well that this would be impracticable with fine work in this country, even in an ordinary summer day. It is not known, in this country, what is the substance which the Indian weavers employ for dressing their warps. It certainly would prove of important benefit to our manufactures were this investigated in a satisfactory manner.

Neither does it appear that this subject, which is of much importance, has hitherto attracted the attention of scientific men, or that it has been treated in an accurate or philosophical manner. It, however, opens a wide field for chemical investigation, and promises to prove equally useful to mankind, and lucrative to the person who may succeed in supplying the desideratum.

When the warp, previously dressed, has been wrought up, as far as can be done conveniently, the weaver is obliged to suspend the operation of weaving, and to prepare a fresh quantity of warp. It is necessary to stop, when the dressed warp has approached within two or three inches of the back leaf of the heddles, that room may be allowed to join the old dressing to the new. The first operation, as in wool and silk, is to clear the warp, with the comb, from the lease rod to the yarn roll, or beam. The proof that this operation has been properly executed is, by bringing back the rods,

successively, from their working situation to the roll. When this has been done, the two rods nearest to the heddles, are drawn out of the warp to one side, and the lease rod only remains. The next duty of the weaver is, to examine the yarn about to be dressed, and carefully to take away every knot, lump, or other obstruction, which might impede the progress of the work, or injure the fabric of the cloth. In silk warps no further dressing is necessary, but in cotton warps the weaver proceeds to apply the substance used for dressing, which is rubbed gently, but completely, into the whole warp, by means of two brushes used in succession, one of which he holds in each hand. He then raises the lease rod, which in cotton-weaving is a middle rod, on one edge, to divide the warp, and sets the air in motion by moving a large fan, for the purpose of drying the warp which has been dressed. Fustian-weavers use a large red-hot iron for this purpose. It is proper, in this stage of the operation, to draw one of the dressing brushes lightly over the warp at intervals, in order to prevent any obstruction, which might arise by the threads, when agitated by the fan, cohering, or sticking to each other, whilst in a wet state. Whenever the warp is sufficiently dried, a very small quantity of grease is brushed over it, the lease rod is again placed upon its flat side, and cautiously shifted forward to the heddles. The other rods are then put again into their respective sheds, and the process is finished.

The first operation of dressing the warp being finished, the weaver begins that of forming the cloth. The operations required, are only three, and these are very simple:

1st. Opening the sheds in the warp, alternately, by pressing the treddles with his foot.

2d. Driving the shuttle through each shed, when opened. This is performed by the right hand, when the fly shuttle is used, and by the right and left hand, alternately, in the common operation.

3d. Pulling forward the lay, or batten, to strike home the woof, and again pushing it back nearly to the heddles. This is done by the left hand with the fly, and by each hand, successively, in the old way. See *Fly Shuttle*, in MANUFACTURE *of Cotton*.

In describing operations so simple and uniform, it is neither easy nor necessary to go much into detail.

By examining any piece of plain cloth, it will be found to be composed of two or more distinct sets of threads, or filaments, running in opposite directions perpendicularly to each other, those threads (or, as some weavers call them, yarns) in the direction of the cloth's length are called the warp, and extend entirely from one end of the piece of cloth to the other. The thread, or yarn, running across the cloth in an horizontal direction is called the woof, or weft. It is in fact one continued thread through the whole piece of cloth, being woven alternately over and under each yarn of the warp, until it arrives at the outside one. It then passes round the yarn, and returns back over and under each thread, as before, but in such a manner that it now goes over each yarn which it passed under before, thus firmly knitting or weaving the whole together. The outside yarn of the warp, round which the woof is doubled, is called the selvage, and cannot be unravelled without breaking the woof. The breadth of the cloth determines the number of yarns the warp shall contain; and its quality limits their distances from each other, and determines the fineness or set of the reed.

Though we have already generally explained the references to the plates, it will be necessary to be more minute in our description, in order to show the use to which the different parts of the apparatus are applied: *d d* are two sticks, connected together by several threads; which system of threads is called a heddle: *e e* is another heddle behind the former. In the middle of each thread composing the heddle is a loop, through which the yarns of the warp are passed, one half of them going through the loops of the heddle, *e e*, the other half of the yarns passing between the threads of the heddle, and afterwards through the eyes or loops of the other heddle, *d d*. The two heddles, *d d* and *e e*, are connected together by two small cords going over pulleys suspended from the top of the loom, so that when one heddle is drawn down the other will be raised up. The heddles receive their motion from the levers, or treddles, D E, moved by the weaver's foot. The yarns of the warp are passed alternately through the loops of the heddles, so that by pressing down one treddle, as E, all the yarns belonging to the heddle, *e e*, are drawn down and, by means of the cords and pulleys, the other heddle, *d d*, with all the yarns belonging to it, are raised up, leaving a space, called the shed, of about two inches between the yarns. F G, G H (fig. 2) is a frame called the batten, or lay, suspended by the bar, F, from the

upper rails of the loom, so that it can swing backwards and forwards. The bottom bar, H, is much broader than the rails, G G, and projects before their plane about an inch and a half, forming a shelf called the shuttle-race. The ends of the bar, H, have boards nailed on each side, and at the ends, to form two short troughs, or boxes, I I, in which pieces of wood, or thick leather, *k k*, called peckers, or drivers, traverse: they are guided by two small wires, fixed at one end to the uprights, G G, and at the other to the end pieces of the troughs, I I. Each pecker has a string fastened to it, tied to the handle, *y*, which the weaver holds in his right hand when at work, and with which he pulls each pecker, alternately, forward. R, is a small frame fixed upon the shuttle-race, H, formed of a number of small pieces of split reeds, or canes, or else of pieces of flat wire of steel or brass. This frame is called the reed. When this is in its place, the yarns of the warp pass between the canes, or dents. The shuttle is a small piece of wood, pointed at each end, about six inches long. It has an oblong mortice in it, containing a small bobbin, on which is wound the weft, which runs through a small hole in the shuttle, called the eye. The shuttle has two little wheels on the under side, by which it runs upon the shuttle-race, H. See *Fly Shuttle*, in the article MANUFACTURE *of Cotton*.

The weaver sits on the seat M, (fig. 1) which hangs by pivots at its ends, that it may adapt itself to the ease of the weaver when he sits upon it. It is lifted out when the weaver gets into the loom, and he puts it in again after him. He leans lightly against the cloth roll, B, and places his feet upon the treddles, D E. In his right hand he holds the handle, *y*, (fig. 2) and by his left he lays hold of a bar, called the lay-cape, which crosses the batten, or lay, G G, and serves to support the upper edge of the reed, R. He commences the operation by pressing down one of the treddles with his foot: this depresses one half of the yarns of the warp, and raises the other, as before described: the shuttle is placed in one of the troughs, I, against the pecker, *k*, belonging to that trough: by drawing the handle of the pecker with a sudden jerk, he drives the pecker against the shuttle, and throws it across the warp upon the shuttle race into the other trough, I, leaving the yarn of the woof which was wound on the bobbin after it. With his left he then pulls the lay towards him, by means of the reed, the yarn of the woof, which before was lying loose between the warp, is driven up towards the cloth roll: the weaver now presses down his other foot, which reverses the operation, pulling down the heddle which was up before, and raising that which before was depressed: by the other pecker he now throws the shuttle back again, leaving the woof after it between the yarns of the warp; and, by drawing up the batten, beats it close up to the thread before thrown. In this manner the operation is continued until a few inches are woven, it is then wound upon the cloth roll, by putting a short lever into a hole made in the roll, and turning it round. A click, acting in the teeth of a serated wheel, prevents the return of the roll. The yarn roll, A (fig. 1), has at each end a cord wound round it. One end of this cord is tied to the frame of the loom, the other has a weight hung to it: this rope causes a friction, which prevents its turning (unless the yarn is drawn by the cloth beam), and always preserves a proper degree of tension in the yarn. T T (fig. 1) are two smooth sticks (cotton weavers have usually three) put between the yarns, to preserve the lease, and keep the threads, or yarns, from entangling. In cotton weaving, these sticks, or rods, are kept at an uniform distance from the heddles, either by tying them together, or by a small cord with a hook at one end, which lays hold of the front rod, and a weight at the other, which hangs over the yarn beam. The cloth is kept extended during the operation of weaving, by means of two pieces of hard wood, with small sharp points in their ends, which lay hold of the edges, or selvages, of the cloth. These pieces are connected by a cord, passing obliquely through holes, or notches, in each piece. By this cord they can be lengthened or shortened, according to the breadth of the web. They are kept flat after the cloth is stretched by a small bar turning on a centre fixed in one of the pieces, with its longer end projecting closely over the edge of the other piece. These pieces of wood, thus formed, are called the temples. Silk-weavers usually stretch their cloth by means of two small sharp pointed hooks, fastened to the ends of two strings, with little weights at the other ends, and the strings are made to pass over little pulleys in each side of the loom, at a suitable distance from the selvages of the cloth.

In the treading of a web, most beginners are apt to apply the weight, or force, of the foot much too suddenly. The bad consequences attending this mistake, are parti-

cularly felt in weaving fine or weak cotton yarn. In weaving, as in every other branch of mechanics, the resistance, or reaction, is always nearly as great as the moving power, or force, which it is necessary to apply. From this it follows, that the body of the warp must sustain a stress, nearly equal to the force, with which the weaver's foot is applied to the treddle. Besides this, every individual thread is subjected, to all the friction, occasioned by the heddles, and splits of the reed, between which the threads pass, and with which they are generally in contact when rising and sinking. But the art of spinning has not been as yet, and probably never can be, brought to such a degree of perfection, as to make every thread capable of bearing its proportion of this stress equally. It is confirmed, both by mathematical demonstration, and by practical experience, that when any body is to be moved with increased velocity, it is necessary to exert greater power to move it; and as the resistance increases in proportion to the power, this sudden application of the pressure of the foot to the treddle, must cause a proportional increase of the stress upon the warp, and also of the friction. Now, as it is impossible to make every thread equally strong, and equally tight, those which are the weakest, or the tightest, must bear much more than their equal proportion of the stress. This causes them to be broken very frequently, and, even with the greatest attention, more time is lost in tying and replacing them, than would have been sufficient for weaving a very considerable quantity into cloth. But when the weaver, from inattention, continues the operation, after one or more threads are broken, the consequence is still worse. When a thread has been broken, it no longer retains its parallel situation to the rest, but crossing over or between those nearest to it, either breaks them also, or interrupts the passage of the shuttle: most frequently it does both.

In every kind of weaving, and especially in thin wiry fabrics, much of the beauty of the cloth depends upon the woof being well stretched. But if the motion of the shuttle be too rapid, it is very apt to recoil, and thus to slacken the thread. It has also a greater tendency either to break the woof altogether, or to unwind it from the pirn or bobbin, in doubles, which, if not picked out, destroy the regularity of the fabric. The woof of muslins and thin cotton goods, is generally woven into the cloth in a wet state. This tends to lay the ends of the fibres of the cotton smooth and parallel, and its effect is similar to that of dressing of the warp. The person who winds the woof upon the pirn, ought to be very careful that it be well built, so as to unwind freely. The best shape for, those used in the fly-shuttle, in cotton weaving, is that of a cone; and the thread ought to traverse freely, in the form of a spiral or screw, during the operation of winding.

The same wheel, used for winding the warp upon bobbins, is also fit for winding the weft. It only requires a spindle of a different shape, with a screw at one end, upon which the pirn is fixed. The wheel is so constructed, that the spindles may be easily shifted, to adapt it for either purpose.

That the fabric of the cloth may be uniform in thickness, it is necessary that the lay, or batten, should be brought forward with the same force every time. In the common operation of weaving, this regularity must be acquired by practice. It is, however, of consequence to the weaver, to mount, or prepare, his loom in such a manner, that the range of the lay may be in proportion to the thickness of his cloth. As the lay swings, backward and forward, upon centres placed above, its motion is similar to that of a pendulum. Now the greater the arc, or range, through which the lay passes, the greater will be its effect, in driving home the weft strongly, and the thicker will be the fabric of cloth, in so far as that depends upon the weft. For this reason, in weaving coarse and heavy goods, the heddles ought to be hung at a greater distance from the point where the weft is struck up, than would be proper in light work. The point, or rather line, where the last wrought shot of weft is struck up, is called by weavers the fell. The pivots, upon which the lay vibrates, ought, in general, to be exactly at equal distances from a line drawn perpendicular to the fell, and one drawn perpendicular to the heddles, and between these two lines. But as the fell is constantly varying in its situation, during the operation, it will be proper to take the medium. This is the place where the fell will be, when a bore (i. e. as much as can be woven without drawing fresh yarn) is half wrought up. From this, the following conclusion may also be drawn: The bores ought always to be short in weaving light goods; for the less that the extremes vary from the medium, the more regular will be the arc, or swing, of the lay.

Having given a general outline of the nature and process of plain weaving; it is necessary, in order to convey to our readers a more comprehensive idea of the art, to notice the fanciful and ornamental parts of the business. The extent to which this species of manufacture is carried renders it an object of very great importance, and deserving a more minute description than our limits will admit.

Stripes are formed upon cloth, either by the warp or by the woof. When the former of these ways is practised, the variation of the process is chiefly the business of the warper: in the latter case it is that of the weaver. By unravelling any shred of striped cloth, it may easily be discovered, whether the stripes have been produced by the operations of the warper or those of the weaver.

Checks are produced by the combined operations of the warper and the weaver.

Tweeled cloths are so various in their textures, and at the same time so complicated in their formation, that it is impossible to convey an adequate idea of the mode of constructing them, without the aid of several engraved figures. In examining any piece of plain cloth, it will be observed, that all the threads in the warp and woof cross each other, and are tacked alternately. This is not the case in tweeled cloths; for in this instance only the third, fourth, fifth, sixth, &c. threads cross each other to form a texture. Tweeled cloths have been fabricated of various descriptions. In the coarsest kinds every third thread is crossed: in finer fabrics, they cross each other at intervals of four, five, six, seven, or eight threads, and in some very fine tweeled silks the crossing does not take place until the sixteenth interval.

Tweeling is produced by multiplying and varying the number of leases in the harness; by the use of a back-harness, or double-harness; by increasing the number of threads in each split of the reed; by an endless variety of modes in drawing the yarns through the harness; and by increasing the number of treddles, and changing the manner of treading them. When the number of treddles requisite to raise all the variety of sheds necessary to produce very extensive patterns would be more than one man could manage, recourse is had to a mode of mounting, or preparing the loom, by the application of cords, &c. to the harness; and a second person is necessary to raise the sheds required, by pulling the strings attached to the respective leases of the back harness, which are sunk to their first position by means of leaden weights underneath. This is the most comprehensive apparatus used by weavers for fanciful patterns of great extent, and it is called the draw-loom. In weaving very fine silk tweels, such as those of sixteen leases, the number of threads drawn through each interval of the reed is so great, that, if woven with a single reed, they would obstruct each other in rising and sinking, and the shed would not be sufficiently open to allow the shuttle a free passage. To avoid this inconvenience, other reeds are placed behind that which strikes up the weft; and the warp threads are so disposed, that those which pass through the same interval in the first reed are divided in passing through the second, and again in passing through the third. By these means the obstruction, if not entirely removed, is greatly lessened.

In the weaving of plain thick woollen cloths, to prevent obstructions of this kind, arising from the closeness of the set, and roughness of the threads, only one fourth of the warp is sunk and raised by one treddle, and a second is pressed down to complete the shed, between the times when every shot of weft is thrown across.

Double cloth is composed of two webs, each of which consists of separate warp and separate weft; but the two are interwoven at intervals. The junction of the two webs is formed by passing each of them occasionally through the other, so that each particular part of both is sometimes above and sometimes below.

This species of weaving is almost exclusively confined to the manufacture of carpets in this country. The material employed is dyed woollen, and, as almost all carpets are decorated with fanciful ornaments, the colours of the two webs are different, and they are made to pass through each other at such intervals as will form the patterns required. Hence it arises, that the patterns of each side of the carpet are the same, but the colours are reversed. Carpets are usually woven in the draw-loom.

Gauze differs in its formation from other cloths, by having the threads of the warp crossed over each other, instead of lying parallel. They are turned to the right and left alternately; and each shot of weft preserves the twine which it has received. This effect is caused by a singular mode of producing the sheds, which cannot easily be described without the aid of drawings.

Cram, or *net-weaving*, is a separate branch of the art, and requires a loom particularly constructed for the purpose.

Spots, *Brocades*, and *Lappets*, are produced by a combination of the arts of plain, tweeled, and gauze weaving, and, as in every other branch of the art, are produced in all their varieties by different ways of forming the sheds, by the application of heddles, and their connections with the treddles which move them. Indeed, the whole knowledge of the art consists in this part of the apparatus of a loom.

In drawing up the foregoing account of the art of weaving we have laboured under inconveniences of no small magnitude. The many different kinds of cloth, the almost infinite variety of ways, though all on the same general principle, of constructing them, the different formation of apparatus in making different cloths; and, lastly, the want of uniformity in the technical phraseology of the art, have all tended to render our descriptions far more intricate and difficult than they otherwise would have been. The assistance, however, which we have derived from the very excellent "Essays on the Art of Weaving," by Mr. Duncan, ought not to pass by us unacknowledged. It is a most curious and valuable publication, embracing almost every thing necessary to be known concerning the art on which it professes to treat.

WEBERA, in botany, a genus of the Pentandria Monogynia class and order. Essential character: contorted; berry inferior, two-celled, cells one-seeded; style elevated, stigma club-shaped, calyx five-cleft. There are three species.

WEDGE, one of the mechanical powers, as they are called. The wedge is a triangular prism, whose bases are equilateral acute-angled triangles. See MECHANICS.

WEEK, in chronology, a division of time comprising seven days. See CHRONOLOGY.

WEIGELIA, in botany, so named in honour of Christ. Ehrenfr. Weigel; a genus of the Pentandria Monogynia class and order. Essential character: calyx five-leaved, corolla funnel form, style from the base of the germ, stigma peltate, seed one. There are two species, viz. W. japonica, and W. coræensis, both natives of Japan.

WEIGHT, in physics, is a quality in natural bodies, by which they tend towards the centre of the earth. See GRAVITATION. Weight may be distinguished into absolute, specific, and relative. It is demonstrated by Sir Isaac Newton: 1. That the weights of all bodies, at equal distances from the centre of the earth, are proportional to the quantities of matter that each contains. 2. On different parts at the earth's surface, the weight of the same body is different; owing to the spheroidal figure of the earth, which causes the bodies on the surface to be nearer the centre in going from the equator towards the poles; and the increase of weight is nearly in proportion to the square of the sine of the latitude: the weight at the equator to that at the pole being as 229 : 230, or the whole increase of weight from the equator to the pole is the 229th part of the former. 3. That the weights of the same body, at different distances above the earth, are inversely as the squares of the distances from the centre. So that a body at the distance of the moon, which is 60 semi-diameters from the earth's centre, would weigh only $\frac{1}{3600}$th part of what it weighs at the surface of the earth. 4. That at different distances within the earth, or below the surface, the weights of the same body are directly as the distances from the earth's centre, so that at half way toward the centre a body would weigh but half as much, and at the centre it would weigh nothing at all. 5. A body immersed in a fluid, which is specifically lighter than itself, loses so much of its weight as is equal to the weight of a quantity of the fluid of the same bulk with itself. Hence a body loses more of its weight in a heavier fluid than in a lighter one, and therefore it weighs more in a lighter fluid than in a heavier one.

The weight of a cubic foot of water is 1000 ounces, or 62½*lb.* avoirdupois; this, multiplied by 32, gives 2000*lb.* the weight of a ton: hence eight cubic feet formerly made a hogshead, and four hogsheads a ton, in capacity as well as in weight. Measures for corn, coals, and other dry articles, were constructed on the same principle. A bushel of wheat, assumed as a general standard for all sorts of grain, weighed 62½*lb.* eight of these make a quarter, and four quarters, or 32 bushels, a ton weight. Coals were sold by the chaldron, and supposed to weigh a ton, though in reality it weighs much more. Hence a ton weight is the common standard for liquids, wheat, and coals. Had this analogy been adhered to, the confusion which is occasioned by different local weights would have been avoided.

To regulate the weights and measures of a country is a branch of the sovereign's prerogative. For the public convenience,

these ought to be universally the same throughout the nation, the better to reduce the prices of articles to equivalent values. But as weight and measure are things in their nature arbitrary and uncertain, it is necessary that they are reduced to some fixed rule or standard. It is, however, impossible to fix such a standard by any written law or oral proclamation: as no person can, by words only, give to another an adequate idea of a pound weight, or foot rule. It is therefore expedient to have recourse to some visible, palpable, material standard, by forming a comparison with which all weights and measures may be reduced to one uniform size. Such a standard was anciently kept at Winchester; and we find in the laws of King Edgar, nearly a century before the conquest, an injunction that this measure should be observed throughout the realm.

Most nations have regulated the standard of measures of length from some parts of the human body: as the palm, the hand, the span, the foot, the cubit, the ell, (ulna or arm) the pace, and the fathom. But as these are of different dimensions in men of different proportions, ancient historians inform us, that a new standard of length was fixed by our King Henry the First; who commanded that the ulna, or ancient ell, which answers to the modern yard, should be made of the exact length of his own arm. See MEASURE.

The standard of weights was originally taken from grains or corns of wheat, whence our lowest denomination of weights is still called a grain; thirty-two of which are directed, by the statute called "compositio mensurarum," to compose a penny-weight, twenty of which make an ounce, and twelve ounces a pound, &c. Under King Richard the First it was ordained, that there should be only one weight and one measure throughout the nation; and that the custody of the assize, or standard of weights and measures, should be committed to certain persons in every city and borough; from whence the ancient office of the king's ulnager seems to have been derived. These original standards were called pondus regis, and mensura domini regis, and are directed by a variety of subsequent statutes to be kept in the exchequer chamber, by an officer called the clerk of the market, except the wine gallon, which is committed to the city of London, and kept in Guildhall. The Scottish standards are distributed among the oldest boroughs. The elward is kept at Edinburgh, the pint at Stirling, the pound at Lanark, and the firlot at Linlithgow.

The two principal weights, established in Great Britain, are troy weight and avoirdupois weight, as before mentioned. Under the head of the former it may further be added, that a carat is a weight of four grains; but when the term is applied to gold, it denotes the degree of fineness. Any quantity of gold is supposed divided into twenty-four parts. If the whole mass is pure gold, it is said to be twenty-four carats fine; if there are twenty-three parts of pure gold, and one part of alloy or base metal, it is said to be twenty-three carats fine, and so on. Pure gold is too soft to be used for coin. The standard coin of this kingdom is 22 carats fine. A pound of standard gold is coined into 44½ guineas, and therefore every guinea should weigh 5 dwts. $9\frac{21}{89}$ grains. A pound of silver for coin contains 11 oz. 2 dwts. pure silver, and 18 dwts. alloy; and standard silver plate 11 ounces pure silver, with one ounce alloy. A pound of standard silver is coined into 62 shillings, and therefore the weight of a shilling should be 3 dwts. $20\frac{20}{31}$ grains.

Under the words avoirdupoise and troy will be found an account of those weights; here we may add a small table from Mr. Ferguson, which gives a more enlarged comparison between these two weights.

175 Troy pounds are equal to 144 avoirdupois pounds.

175 Troy ounces are equal to 192 avoirdupois ounces.

1 Troy pound contains 5760 grains.

1 Avoirdupois pound contains 7000 grains.

1 Avoirdupois ounce contains 437½ grains.

1 Avoirdupois dram contains 27.34375 grains.

1 Troy pound contains 13 *oz.* 2.651428576 drams avoirdupois.

1 Avoirdupois *lb.* contains 1 *lb.* 2 *oz.* 11 *dwts.* 16 *grs.* troy.

Therefore the avoirdupois *lb.* is to the *lb.* troy as 175 to 144, and the avoirdupois *oz.* is to the troy *oz.* as 437½ is to 480.

The moneyers, jewellers, &c. have a particular class of weights for gold and precious stones, viz. carat and grain; and for silver, the penny-weight and grain. The moneyers have also a peculiar subdivision of the troy grain: thus, dividing

The grain into 20 mites,
The mite into 24 droits,
The droit into 20 periots,
The periot into 24 blanks.

The dealers in wool have likewise a particular set of weights: *viz.* the sack, weigh, tod, stone, and clove; the proportions of which are as below; *viz.*

The sack containing.....	2 weighs,
The weigh	$6\frac{1}{2}$ tods,
The tod	2 stones,
The stone..................	2 cloves,
The clove...................	7 pounds.

But these weights differ in almost every county where dealings in wool are carried on largely.

Also 12 sacks make a last, or 4368 pounds.

Further,

56 *lb.* of old hay, or 60 *lb.* new hay, make a truss. See TRUSS.

In order to show the proportion of the several weights used throughout Europe, we shall add a reduction of them to one standard, *viz.* the London and Amsterdam pound.

1. Proportion of the weights of the principal places of Europe.

The 100 *lb.* of England, Scotland, and Ireland, are equal to

lb,	*oz.*	
91	8	of Amsterdam, Paris, &c.
96	8	of Antwerp or Brabant.
88	0	of Rouen, the viscounty weight.
106	0	of Lyons, the city weight.
90	9	of Rochelle.
107	11	of Toulouse and Upper Languedoc.
113	0	of Marseilles or Provence.
81	7	of Geneva.
93	5	of Hamburgh.
89	7	of Francfort, &c.
96	1	of Leipsick, &c.
137	4	of Genoa.
132	11	of Leghorn.
153	11	of Milan.
152	0	of Venice.
154	10	of Naples.
97	0	of Seville, Cadiz, &c.
104	15	of Portugal.
96	5	of Liege.
112	$\frac{3}{4}$	of Russia.
107	$\frac{1}{24}$	of Sweden.
89	$\frac{1}{2}$	of Denmark.

We shall now show the correspondence between English weights and some modern weights in France and other countries, which will be very useful in reading works on statistics and chemistry, as well modern as those that have been long published, and become standard books.

ENGLISH WEIGHTS.

Troy Weight.

lb.	oz.	drms.	scruples.	grains.	grammes.
1 =	12 =	96 =	283 =	5760 =	372.96
	1 =	8 =	24 =	480 =	31.08
		1 =	3 =	60 =	3.885
			1 =	20 =	1.395
				1 =	0.06475

Avoirdupois Weight.

lb.	oz.	drms.	grains.	grammes.
1 =	16 =	256 =	7000	= 453.25
	1 =	16 =	437.5	= 28.32
		1 =	37.975	= 1.81

Correspondence of English weights with those used in France before the revolution.

The Paris pound, poids de marc of Charlemagne, contains 9216 Paris grains: it is divided into 16 ounces, each ounce into 8 gros, and each gros into 72 grains. It is equal to 7561 English troy grains.

The English troy pound of 12 ounces contains 5760 English troy grains, and is equal to 702 Paris grains.

The English avoirdupois pound of 16 ounces contains 7000 English troy grains, and is equal to 8538 Paris grains.

To reduce Paris grains to English troy grains, divide by To reduce English troy grains to Paris grains, multiply by	1.2189
To reduce Paris ounces to English troy, divide by......... To reduce English troy ounces to Paris, multiply by.	1.015734

Or the conversion may be made by means of the following tables.

1. *To reduce French to English troy weight.*

The Paris pound	= 7561	English troy grains.
The ounce	= 472.5624	
The gros	= 59.0703	
The grain	= .8204	

2. *To reduce English troy to Paris weight.*

The English troy pound of 12 ounces...........	= 7021.	Paris grains.
The troy ounce	= 585.0893	
The dram of 60 grains...	= 73.1354	
The pennyweight, or denier, of 24 grains.......	= 29.2541	
The scruple of 20 grains	= 24.3784	
The grain..................	= 1.2189	

3. *To reduce English avoird. to Paris weight.*

The avoirdupois pound of 16 ounces, or 7000 troy grains............	= 8538.	Paris grs.
The ounce	= 533.6250	

TABLE,

Showing the comparison between French and English grains. (*Poid de Marc.*)

French grs	= Eng grs	Eng grs	= French grs.
1	0.8203	1	1.2189
2	1.6407	2	2.4378
3	2.4611	3	3.6568
4	3.2815	4	4.8757
5	4.1019	5	6.0947
6	4.9223	6	7.3136
7	5.7427	7	8.5325
8	6.5631	8	9.7515
9	7.3835	9	10.9704
10	8.203	10	12.189
20	16.407	20	24.378
30	24.611	30	36.568
40	32.815	40	48.757
50	41.019	50	60.947
60	49.223	60	73.136
70	57.427	70	85.325
80	65.631	[illegible]	97.513
90	73.835	90	109.704
100	82.03	100	121.89
200	164.07	200	243.78
300	246.11	300	365.68
400	328.15	400	487.57
500	410.19	500	609.47
600	492.23	600	731.36
700	574.27	700	853.25
800	656.31	800	975.15
900	738.35	900	1097.04
1000	820.3	1000	1218.9
2000	1640.7	2000	2437.8
3000	2461.1	3000	3656.8
4000	3281.5	4000	4875.7
5000	4101.9	5000	6094.7
6000	4922.3	6000	7313.6
7000	5742.7	7000	8532.5
8000	6563.1	8000	9751.5
9000	7383.5	9000	10970.4
10,000	8233.0	10,000	12189.0

GERMAN.

71 *lbs.* or grs. English troy = 74 *lbs.* or grs. German apothecaries weight.

1 oz. Noremberg medic. weight = 7 dr. 2 sc. 9 grains English.

1 mark Cologne = 7 oz. 2 dwt. 4 gr. English troy.

DUTCH.

1 *lb.* Dutch = 1 *lb.* 3 oz. 16 dwt. 7 gr. English troy.

787$\frac{1}{2}$ *lbs.* Dutch = 1068 *lbs.* English troy.

SWEDISH WEIGHTS,

Used by Bergman and Scheele.

The Swedish pound, which is divided like the English apothecary, or troy pound, weighs 6556 grains troy.

The kanne of pure water, according to Bergman, weighs 42250 Swedish grains, and occupies 100 Swedish cubical inches. Hence the kanne of pure water weighs 48088.7 9144 English troy grains, or is equal to 189.9413 English cubic inches; and the Swedish longitudinal inch is equal to 1.238135 English longitudinal inches.

From these data, the following rules are deduced:

1. To reduce Swedish longitudinal inches to English, multiply by 1.2384, or divide by 0.80747.

2. To reduce Swedish to English cubical inches, multiply by 1.9, or divide by 0.5265.

3. To reduce the Swedish pound, ounce, dram, scruple, or grain, to the corresponding English troy denomination, multiply by 1.1382, or divide by 8.786.

4. To reduce the Swedish kannes to English wine pints, multiply by .1520207, or divide by 6.57804.

5. The lod, a weight sometimes used by Bergman, is the 32d part of the Swedish pound: therefore, to reduce it to the English troy pound, multiply by .03557, or divide by 28.1156.

Universal Standard for Weights and Measures.

This is an object of vast importance could it be attained we fear, however, that like a project for universal peace and good will among men, it is a thing rather to be desired than expected, in the present state of things. Philosophers may speculate on the importance and excellence of such a scheme, but statesmen, busy in projects of ambition, have not leisure to attend to any thing that does not augment their power, extend their influence, and render them rather a terror to mankind, than the objects of their praise and veneration. It behoves us, however, to give, in few words, a sketch of what has been attempted with a view to an universal standard for weights and measures through the whole world. The plans laid down have been deduced from philosophical principles. After the invention of pendulum clocks, it occurred that the length of a pendulum which should vibrate seconds would be proper to be made a universal standard for

length, whatever the denomination should be fixed on, whether yard, or any thing else. It was however found, that it would be difficult in practice to measure and determine the true length of such a pendulum, that is, the exact distance between the point of suspension and the point of oscillation. Another cause of inaccuracy was afterwards discovered, when it was found that the second's pendulum was of different lengths in all the different latitudes, owing to the spheroidal figure of the earth, (See EARTH,) which is the cause why places, in different latitudes, at different distances from the centre, and of course the pendulums are acted upon by different forces of gravity, and therefore require to be of different lengths. In the latitude of London this is found to be $39\frac{1}{8}$ inches nearly.

The Society of Arts, &c. have offered premiums for a plan that might accomplish this great object: and among other devices then brought forward was one by Mr. Hatton, which consisted in measuring the difference of the lengths of two pendulums at different times of vibration, which could be performed more easily and accurately than that of the length of one single pendulum. This method was put in practice, and fully explained, and illustrated, by the late Mr. Whitehurst, in his attempts to ascertain an universal standard of weights and measures. The same kind of inaccuracy of measurement obtains in this way, though in a smaller degree, as in a single pendulum. Another method has been proposed, on observing very accurately the space that a heavy body falls freely through in one second of time. Here absolute accuracy is almost unattainable, besides, the form of the earth introduces difficulties, owing to the different distances from the centre, and the consequent diversity in the force of gravity by which the body falls. This space, in the latitude of London, has been found 193 inches, of course it is different in other latitudes. The method of late years, proposed by the French, is that of measuring a degree on the earth's surface, at the latitude of 45 degrees, and from this to deduce an universal measure of lengths, which would be easily applicable to weights also.

WEIGHTS and MEASURES, in law. The standard of measures was originally kept at Winchester, which measure was, by the law of King Edgar, ordained to be observed throughout the kingdom. By statute 35 George III. c. 102, the justices in quarter sessions, in every county, are required to appoint persons to examine the weights and balances within their respective jurisdictions. These inspectors may seize and examine weights in shops, &c. and seize false weights and balances, and the offender, being convicted before one justice, shall be fined from five shillings to twenty shillings. Persons obstructing the inspectors, to forfeit from five shillings to forty shillings. Inspectors to be recompensed out of the county rate. Standard weights to be purchased by the sessions out of the county rate, and produced to all persons paying for the production thereof. Informations to be within one month.

WEINMANNIA, in botany, so named in honour of Joh. Wilh. Weinmann, a genus of the Octandria Digynia class and order. Natural order of Saxifragæ, Jussieu. Essential character: calyx four-leaved, corolla four-petalled, capsule two-celled, two-beaked. There are six species.

WELDING. Welding is that intimate union produced between the surfaces of two pieces of malleable metal, when heated almost to fusion, and hammered. This union is so strong, that when two bars of metal are properly welded, the place of junction is as strong, relatively to its thickness, as any other part of the bar. Only two of the old metals are capable of firm union by welding, namely platina and iron; the same properly belongs to the newly discovered metals, potassium and sodium.

WERNERITE, in mineralogy, is of a colour between yellow and green, it occurs crystallized, specific gravity is about 3.6. It intumesces before the blow pipe, and melts into a whitish enamel. It is found in the iron mines in Sweden and Norway.

WESTRINGIA, in botany, so named in honour of John Peter Westring, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: calyx half, five-cleft, five-sided, corolla reversed, with four segments, the longest erect, cloven; stamens distant, the two shorter, or lowest, abortive. There is only one species, viz. W. rosmariniformis, a native of New South Wales, near Port Jackson.

WHALE. See BALÆNA.

WHALE *fishery*. See FISHERY.

WHARF, a space on the banks of a haven, creek, or hithe, provided for the convenient loading and unloading of vessels upon. The fee paid for the landing of goods on a wharf, or for shipping them off,

is called wharfage, and the person who has the direction and oversight of the wharf, receives wharfage, &c. is called the wharfinger.

WHEAT. See TRITICUM.

WHEEL. This is one of the six powers of mechanism; and without doubt, contributes more than any of the other five to the general convenience of mankind; by the wonderful variety of purposes, from a mill to a watch, wherein it is employed. It is our intention, however, in this place, to confine ourselves to the wheel as appertaining to vehicles in general, referring the readers to the articles MILL *work*, WATCH *work*, CLOCK *work*, &c. for the application of such wheels as come within those branches of the arts.

Of carriage wheels, in general, we shall then treat; observing, that any attempt to prove that a carriage is more easily drawn upon wheels than upon sledges, would be an affront to the understanding of the reader. But whether high, or low, wheels are fitted for the purpose, has been a subject of dispute, even among persons of skill. Reason and experience, however, seem perfectly to agree in this, that wheels, whose centres are on a level with the moving power, will be easiest drawn along a level plane; and that the higher a wheel is the more easily will it get over the obstacles it may meet with, provided the moving power be not below the centre. It seems to follow, therefore, that carriages drawn by horses, or oxen, should have wheels whose centres have the height of the draft line; that is, of the shoulders of the horses, or the yokes of the oxen. This is true, however, only in the case of a horizontal road; in going up hill the distance of the line of draught from the road is somewhat less; because, when a man, or any other animal, is standing upon the side of a slope, his height is inclined to that slope; or rather the slope is inclined towards him, where he stands perfectly perpendicular. This being the situation in which cattle labour most, it is necessary to proportion the draft, so as to render it as light as possible while drawing up hill; therefore, it is usual, and highly proper so to proportion the height of the axle, especially in carts with two wheels, to the point of draught, that the line drawn from the centre of the wheel to that point, should rise at an angle of about twelve or fourteen degrees; thus, when the horse is labouring up hill he will come nearly to a level with the wheel's centre, and draw to the greatest advantage. This may serve as a general rule; but where local circumstances prevail of a different tendency, and also in particular cases, the height of the wheels must be suited to meet such. We reckon that in ordinary work, and where the horses do not exceed the height of fifteen hands and a half, the wheels should be from four feet eight inches to five feet two. Yet the immense loads drawn in the coal carts at Glasgow, on wheels more than six feet high, and other instances of a like kind, prove that very great powers are gained by using high wheels; under due construction and application the difference of the wheel's weight will not prove any material drawback. In ascending, high wheels will be found to facilitate the draught in exact ratio with the squares of their diameters; but in descending they are liable to press in the same proportion. An admirable device was produced by Lord Somerville, for throwing the weight behind the centre in going down hill, by cocking the fore-part of the body of a cart; so that while the shaft may incline downwards, in proportion to the line of declivity, the bottom of the cart's body should remain horizontal; this construction is now common in Devonshire, Somersetshire, &c.

Wheels are commonly made with what is called a dish; that is, the spokes are set at an angle into the nave, or centre-piece; so that, when the interior end of the nave is placed on the ground, the wheel may appear to be dished, or hollow, in the centre. Experience has shown, that when wheels have been made cylindrical, and not with the conical hollow just described, so that the spokes stood at right angles with the centre of the axle, numberless inconveniences arose; the dirt taken up by the wheel used to fall in between the nave and the axle, so as to choak and wear it considerably. Such wheels also required to stand wider apart, and demanded greater road way; besides they were very apt to be wrenched when pressed by any exterior resistance, and the spokes were forced back in the mortices. According to the present plan of dishing wheels, usually to about four inches in five feet of diameter, the exterior resistances are avoided; the axle being so turned down at its ends, as to cause the lower spoke, which bears up the load, to stand perpendicularly under the centre; thus occasioning the upper parts of the two wheels on the same angle to spread from each other; while the lower parts con-

verge in the same proportion. Cylindrical wheels, that is, such as are not dished, would answer, provided the carriage were always on a perfectly horizontal plane; but they would subject the nave to be loaded with mud, and pinch the load when consisting of light articles rising above the body of the carriage.

The spokes should be set so far from the outer end of the nave, that a perpendicular from the sole to the under side of the axle may fall, between an inch, and two inches, between the bushes. By this, the pressure will be somewhat greater on the outer than on the inward bush, when the wheels are on a level. This ought to be so; for the inner part of the axle arm being much bigger than the outer, it has more friction; therefore should have less pressure; besides, every sinking of the wheel, more than the other, causes it to pinch the inner bush. The best mode of placing spokes in the naves, is to mortice them in two rows, alternately; this does not weaken the centre so much as when all the spokes are in one row, or band, and gives a greater degree of resistance outwards. The tire, or iron binding of a wheel must be so laid on, whether in one or more bands, as to form the frustrum of a cone; but in heavy waggons it is usual to make the middle of the tire rise considerably, so as to bear the whole weight on hard roads, whereby the carriage will move lighter than if the frustrum were rectilinear; this form likewise causes stones, &c. to slip aside; but in soft soils it is apt to occasion much sinking. The axle arm should be taper, in order that it may give the wheel rather a disposition to slide off; otherwise it would be apt to close inwardly, and create excessive friction; hence the necessity for good iron wasters exteriorly, and substantial linch-pins. There is a common practice of setting the wheels forward; that is, giving them a slight inclination towards each other, whereby they are perhaps an inch nearer at their front than at their backs; this is done to make the wheel run more even on its sole, or bearing part, and to prevent its gaping forward; but it is evidently a distortion which prevents the wheel from running exactly at right angles with the transverse section of the carriage. The nave of a heavy wheel, that is for our ordinary cart for field purposes, need not be more than twelve or fourteen inches in length; if too short, the wheel will wabble, unless fitted very tight on the axle; while too long a nave is apt to catch the dirt from the upper part, and to project too much beyond the outer face of the fellies; the above length is exclusive of the pan at the outer end.

The proportions of wheels must be estimated according to the purposes to which they are to be applied; thus waggons have in general large hind-wheels, while in timber carriages the four are usually of the same height, or nearly so; the London common stage carts have large wheels, while the drays used by brewers have very low ones. The reason is obvious; waggons and carts load behind; but timber carriages and drays load at the sides, therefore, in such, large wheels, however much they might favour the draught, would be extremely inconvenient; indeed incompatible. Wheels, whatever their size, should be made of well seasoned tough wood, perfectly free from blemish; the naves are generally of elm, the spokes of oak, and the fellies of elm, or of ash; such are found to answer best for all carriages attached to the ordnance department; in which the following are considered as the regular standard heights.

All the horse-artillery carriages, limbers, and waggons; the heavy six-pounders, and long three-pounders, and their limbers; the carriage of a six-pounder battalion gun; of a light five and a half inch howitzer; and the hind wheels of an ammunition waggon, five feet. The limber to a light six-pounder, and five and a half inch howitzer; the carriage of a medium twelve-pounder, four feet eight inches. The limber of the latter four feet six inches. A sling-cart, five feet eight inches. The fore-wheels of an ammunition waggon, four feet. A pontoon carriage has the fore-wheels three feet, and the hind ones five feet six inches. The carriage of an eight inch howitzer, five feet; the limber, four feet. A ball ammunition cart, five feet.

We are disposed to recommend these proportions to the consideration of readers concerned in the construction, or in the use of wheel carriages; they being the result of innumerable experiments, submitted to unequivocal proof under every variety of locality and of burthen. We think it necessary, at the same time to observe, that a correspondent of the Agricultural Magazine, formerly published by Longman, Hurst, Rees, and Orme, of Paternoster-row, has, in the eleventh number of that work, given, what appears to be, an excellent rule for the proportions of wheels in waggons. It would

not be admissible for us to give the whole of the reasonings of that correspondent as contained in various numbers; but from that which we have particularized we have the pleasure to furnish the following extract; or, at least, the sense of it.

"If the fore-wheel be four feet four inches in height, and the line of traction (draught) be drawn at an elevation of twelve degrees from the centre of its axle, the point where that line cuts the circumference of the wheel in its front, gives that height from the plane on which the carriage stands, that will determine the radius of the hinder wheel. In this instance the hind-wheel would have a radius of two feet nine inches, giving of course five feet six inches for its diameter."

A view of the plate given in that work, not only will illustrate the above explanation, but will satisfy a person respecting the justness of the proportions above detailed; when tempered by the following cautions, we consider the instruction given to be admirable. "The fore-wheel ought to be as nearly level with the point of draught, that is, where the shaft is suspended by the gear, as may be convenient; observing, that an angle of twelve degrees is to be given on account of the difference between the horse's height as he stands at rest, and the real altitude of the point of draught from the ground, when he is in a state of exertion. During great efforts, horses lose very considerably of their standard, and thus bring the shaft to nearly a parallel with the plane on which they move. Attention must be paid to keeping the wheel within such limits as may not trespass on other matters, often of more consequence even than ease of draught; loading, turning, weight, expense, &c. must always form a part of the calculation."

WHEEL *work*. Of all the modes of communicating motion, the most extensively useful is the employment of wheel-work, which is capable of varying its direction and its velocity without any limit.

Wheels are sometimes turned by simple contact with each other; sometimes by the intervention of cords, straps, or chains, passing over them; and in these cases the minute protuberance of the surfaces, or whatever else may be the cause of friction, prevents their sliding on each other. Where a broad strap runs on a wheel, it is usually confined to its situation, not by causing the margin of the wheel to project, but, on the contrary, by making the middle prominent; the reason of this may be understood by examining the manner in which a tight strap running on a cone would tend to run towards its thickest part. Sometimes also pins are fixed in the wheels, and admitted into perforations in the straps; a mode only practicable where the motion is slow and steady. A smooth motion may also be obtained, with considerable force, by forming the surfaces of the wheels into brushes of hair. More commonly, however, the circumferences of the contiguous wheels are formed into teeth, impelling each other, as with the extremities of so many levers, either exactly or nearly in the common direction of the circumferences; and sometimes an endless screw is substituted for one of the wheels. In forming the teeth of wheels, it is of consequence to determine the curvature which will procure an equable communication of motion, with the least possible friction. For the equable communication of motion, two methods have been recommended; one, that the lower part of the face of each tooth should be a straight line in the direction of the radius, and the upper a portion of an epicycloid, that is, of a curve described by a point of a circle rolling on the wheel, of which the diameter must be half that of the opposite wheel; and in this case it is demonstrable that the plane surface of each tooth will act on the curved surface of the opposite tooth so as to produce an equable angular motion in both wheels; the other method is, to form all the surfaces into portions of the involutes of circles, or the curves described by a point of a thread which has been wound round the wheel, while it is uncoiled; and this method appears to answer the purpose in an easier and simpler manner than the former. It may be experimentally demonstrated, that an equable motion is produced by the action of these curves on each other; if we cut two boards into forms terminated by them, divide the surfaces by lines into equal or proportional angular portions, and fix them on any two centres, we shall find that as they revolve, whatever parts of the surfaces may be in contact, the corresponding lines will always meet each other.

Both these methods may be derived from the general principle, that the teeth of the one wheel must be of such a form, that their outline may be described by the revolution of a curve upon a given circle, while the outline of the teeth of the other wheel is described by the same curve revolving within the circle. It has been sup-

posed by some of the best authors that the epicycloidal tooth has also the advantage of completely avoiding friction; this is however by no means true, and it is even impracticable to invent any form for the teeth of a wheel, which will enable them to act on other teeth without friction. In order to diminish it as much as possible, the teeth must be as small and as numerous as is consistent with strength and durability; for the effect of friction always increases with the distance of the point of contact from the line joining the centres of the wheels. In calculating the quantity of the friction, the velocity with which the parts slide over each other has generally been taken for its measure; this is a slight inaccuracy of conception for it is certain that, the actual resistance is not at all increased by increasing the relative velocity; but the effect of that resistance, in retarding the motion of the wheels, may be shown, from the general laws of mechanics, to be proportional to the relative velocity thus ascertained. When it is possible to make one wheel act on teeth fixed in the concave surface of another, the friction may be thus diminished in the proportion of the difference of the diameters to their sum. If the face of the teeth, where they are in contact, is too much inclined to the radius, their mutual friction is not much affected, but a great pressure on their axis is produced; and this occasions a strain on the machinery, as well as an increase of the friction on the axis. If it is desired to produce a great angular velocity with the smallest possible quantity of wheel-work, the diameter of each wheel must be between three and four times as great as that of the pinion on which it acts. Where the pinion impels the wheel, it is sometimes made with three or four teeth only; but it is much better in general to have at least six or eight; and considering the additional labour of increasing the number of wheels, it may be advisable to allot more teeth to each of them than the number resulting from the calculation; so that we may allow thirty or forty teeth to a wheel acting on a pinion of six or eight. In works which do not require a great degree of strength, the wheels have sometimes a much greater number of teeth than this; and on the other hand, an endless screw or a spiral acts as a pinion of one tooth, since it propels the wheel through the breadth of one tooth only in each revolution. For a pinion of six teeth, it would be better to have a wheel of thirty-five or thirty-seven than thirty-six; for each tooth of the wheel would thus act in turn upon each tooth of the pinion, and the work would be more equally worn than if the same teeth continued to meet in each revolution. The teeth of the pinion should also be somewhat stronger than those of the wheel, in order to support the more frequent recurrence of friction. It has been proposed, for the coarser kinds of wheel-work, to divide the distance between the middle points of two adjoining teeth into thirty parts, and to allot sixteen to the tooth of the pinion, and thirteen to that of the wheel, allowing one for freedom of motion.

The wheel and pinion may either be situated in the same plane, both being commonly of the kind denominated spur-wheels, or their planes may form an angle; in this case one of them may be a crown or contrate wheel; or both of them may be bevelled, the teeth being cut obliquely. According to the relative magnitude of the wheels, the angle of the bevel must be different, so that the velocities of the wheels may be in the same proportion at both ends of their oblique faces; for this purpose, the faces of all the teeth must be directed to the point where the axes would meet. In cases where a motion not quite equable is required, as it sometimes happens in the construction of clocks, but more frequently in orreries, the wheels may either be divided a little unequally, or the axis may be placed a little out of the centre; and these eccentric wheels may either act on other eccentric wheels, or if they are made as contrate wheels, upon a lengthened pinion. An arrangement is sometimes made for separating wheels which are intended to turn each other, and for replacing them at pleasure; the wheels are said to be thrown by these operations out of gear and into gear again. When a wheel revolves round another, and is so fixed as to remain nearly in a parallel direction, and to cause the central wheel to turn round its axis, the apparatus is called a sun and planet wheel. In this case, the circumference of the central wheel moves as fast as that of the revolving wheel, each point of which describes a circle equal in diameter to the distance of the centres of the two wheels; consequently, when the wheels are equal, the central wheel makes two revolutions, every time that the exterior wheel travels round it. If the central wheel be fixed, and the exterior wheel be caused to turn on its own centre during its revolution, by the effect of the contact of the teeth, it will make in

every revolution one turn more with respect to the surrounding objects, than it would make, if its centre were at rest, during one turn of the wheel which is fixed; and this circumstance must be recollected when such wheels are employed in planetariums.

Wheels are usually made of wood, of iron, either cast or wrought, of steel, or of brass. The teeth of wheels of metal are generally cut by means of a machine; the wheel is fixed on an axis, which also carries a plate furnished with a variety of circles, divided into different numbers of equal parts, marked by small excavations; these are brought in succession under the point of a spring, which holds the axis firm, while the intervals between the teeth are expeditiously cut out by a revolving saw of steel. The teeth are afterwards finished by a file; and a machine has also been invented for holding and working the file. It is frequently necessary in machinery to protract the time of application of a given force, or to reserve a part of it for future use. This is generally effected by suffering a weight to descend, which has been previously raised, or a spring to unbend itself from a state of forcible flexure, as is exemplified in the weights and springs of clocks and watches. The common kitchen jack is also employed for protracting and equalizing the operation of a weight; in the patent jack the same effect is produced by an alternate motion, the axis being impelled backwards and forwards, as in clocks and watches, by means of an escapement, and the place of a balance spring being supplied by the twisting and untwisting of a cord.

In these machines, as well as in many others of greater magnitude, the fly wheel is a very important part, its velocity being increased by the operation of any part of the force which happens to be superfluous, and its rotatory power serving to continue the motion when the force is diminished or withdrawn. Thus, when a man turns a winch, he can exert twice as much force in some positions as in others, and a fly enables him in some cases to do nearly one-third more work. In the pile engine, also, without the help of the fly, the horses would fall for want of a counterpoise, as soon as the weight is disengaged. Such a fly ought to be heavy, and its motion must not be too rapid, otherwise the resistance of the air will destroy too much of the motion; but in the kitchen jack, as well as in the striking part of a clock, where the superfluous force is purposely destroyed, the fly is made light, and strikes the air with a broad surface. An effect similar to that of a fly and a spring is sometimes produced in hydraulic machines by the introduction of an air vessel, the air contained in which is compressed more or less according to the intensity of the force, and exerts a more uniform pressure in expelling the fluid which is forced irregularly into it. See Young's Lectures.

Wheel, in the military art, is the word of command when a battalion or squadron is to alter its front either one way or the other. To wheel to the right, directs the man in the right angle to turn very slowly, and every one to wheel from the left to the right, regarding him as their centre; and *vice versa* when they are to wheel to the left. When a division of men are on the march, if the word be to wheel to the right or to the left, then the right or left hand man keeps his ground, only turning on his heel, and the rest of the rank move about quick till they make an even line with the said right or left hand man.

Wheels, *water*. See Mill.

WHIRLWIND, a wind that rises suddenly, is exceedingly rapid and impetuous, in a whirling direction, and often progressively also; but it is commonly soon spent. Dr. Franklin, in his Physical and Meteorological Observations, read to the Royal Society in 1756, supposes a whirlwind and a water-spout to proceed from the same cause: their only difference being, that the latter passes over the water, and the former over the land. This opinion is corroborated by the observations of many others, who have remarked the appearances and effects of both to be the same. They have both a progressive as well as a circular motion; they usually rise after calms and great heats, and mostly happen in the warmer latitudes: the wind blows every way from a large surrounding space, both to the water-spout and whirlwind; and a water-spout has, by its progressive motion, passed from the sea to the land, and produced all the phenomena and effects of a whirlwind; so that there is no reason to doubt that they are meteors arising from the same general cause, and explicable upon the same principles, furnished by electrical experiments and discoveries.

WHISPERING *places*, are places where a whisper, or other small noise, may be heard from one part to another, to a great distance. They depend on a principle, that

the voice, &c. being applied to one end of an arch, easily passes by repeated reflections to the other.

Hence sound is conveyed from one side of a whispering-gallery to the opposite one, without being perceived by those who stand in the middle. The form of a whispering-gallery is that of a segment of a sphere, or the like arched figure; and the progress of the sound through it may be illustrated in the following manner: Let A B C (Plate XVI. Miscel. fig. 12.) represent the segment of a sphere; and suppose a low voice uttered at A, the vibrations extending themselves every way, some of them will impinge upon the points E, E, &c.; and thence be reflected to the points F, F, &c.; thence to G, G, &c.; till at last they meet in C; where by their union they cause a much stronger sound than in any part of the segment whatever, even at A, the point from whence they came. Accordingly, all the contrivance in whispering-places is, that near the person who whispers there may be a smooth wall, arched either cylindrically or elliptically. A circular arch will do, but not so well.

The most considerable whispering-places in England are, the whispering-gallery in the dome of St. Paul's, London, where the ticking of a watch may be heard from side to side, and a very easy whisper be sent all round the dome. The famous whispering place in Gloucester Cathedral, is no other than a gallery above the east end of the choir, leading from one side thereof to the other. It consists of five angles and six sides, the middlemost of which is a naked window, yet two whisperers hear each other at the distance of twenty-five yards.

WHISTON, (William), an English divine, philosopher, and mathematician, of uncommon parts, learning, and extraordinary character, was born the 9th of December 1667, at Norton in the county of Leicester, where his father was rector. He was educated under his father till he was seventeen years of age, when he was sent to Tamworth school, and two years after admitted of Clare-hall, Cambridge, where he pursued his studies, and particularly the mathematics, with great diligence.

In 1693, he was made Master of Arts, and Fellow of the College, and soon after commenced one of the tutors; but his ill state of health soon after obliged him to relinquish this profession. Having entered into orders, in 1694, he became chaplain to Dr. More, Bishop of Norwich; and while in this station he published his first work, entitled, "A New Theory of the Earth, &c." in which he undertook to prove that the Mosaic doctrine of the earth was perfectly agreeable to reason and philosophy: which work, having much ingenuity, brought considerable reputation to the author.

In the year 1698, Bishop More gave him the living of Lowestoff in Suffolk, where he immediately went to reside, and devoted himself with great diligence to the discharge of that trust. In the begining of the last century he was made Sir Isaac Newton's deputy, and afterwards his successor in the Lucasian professorship of mathematics, when he resigned his living at Lowestoff, and went to reside at Cambridge. From this time his publications became very frequent, both in theology and mathematics. By his researches into the writings of the Fathers, he was led to embrace the Arian hypothesis respecting the person of Christ; on account of which he was, in October 1710, deprived of his professorship, and expelled the University of Cambridge, after he had been formally convened and interrogated for some days together. At the conclusion of this year he wrote his "Historical Preface," afterwards prefixed to his "Primitive Christianity Revived," containing the reasons for his dissent from the commonly received notions of the Trinity, which work he published the next year, in 4 vols. 8vo. for which the Convocation fell upon him most vehemently.

In 1713, he and Mr. Ditton composed their scheme for finding the longitude, which they published the year following, a method which consisted in measuring distances by means of the velocity of sound.

On Mr. Whiston's expulsion from Cambridge, he went to London, where he conferred with Doctors Clarke, Hoadly, and other learned men, who endeavoured to moderate his zeal, but he was not to be intimidated, he continued to write, and to propagate his opinions with as much ardour as if he had been in the most flourishing circumstances; which, however, were so bad that, in 1721, a subscription was made for the support of his family, which amounted to 470*l*. For though he drew some profits from reading astronomical and philosophical lectures, and also from his publications, which were very numerous, yet these of themselves were very insufficient: nor, when joined with the benevolence and charity of those who loved and esteemed him

for his learning, integrity, and piety, did they prevent his being frequently in great distress.

In 1739, Mr. Whiston put in his claim to the mathematical professorship at Cambridge, then vacant by the death of Dr. Saunderson, in a letter to Dr. Ashton, the Master of Jesus College; but no regard was paid to it. Among a variety of works, he published Memoirs of his own Life and Writings, which are very curious.

Whiston continued many years a member of the established Church; but at length forsook it on account of the reading of the Athanasian Creed, and went over to the Baptists; which happened while he was at the house of Samuel Barker, Esq. at Lindon in Rutlandshire, who had married his daughter; where he died, after a week's illness, the 22d of August 1752, at upwards of 84 years of age.

The character of this conscientious and worthy man has been attempted by two very able personages, who were well acquainted with him, namely, Bishop Hare and Mr. Collins, who unite in giving him the highest applauses for his integrity, piety, &c. Mr. Whiston left some children behind him; among them, Mr. John Whiston, who was for many years a very considerable bookseller in London.

WHITE, one of the colours of bodies. Though white cannot properly be said to be one colour, but rather a composition of all the colours together: for Newton has demonstrated that bodies only appear white by reflecting all the kinds of coloured rays alike; and that even the light of the sun is only white because it consists of all colours mixed together.

This may be shown mechanically in the following manner: Take seven parcels of coloured fine powders, the same as the primary colours of the rainbow, taking such quantities of these as shall be proportional to the respective breadths of these colours in the rainbow which are of red 45 parts, orange 27, yellow 48, green 60, blue 60, indigo 40, and of violet 80; then mix intimately together these seven parcels of powders, and the mixture will be a whitish colour: and this is only similar to the uniting the prismatic colours together again, to form a white ray or pencil of light of the whole of them. The same thing is done conveniently thus: Let the flat upper surface of a top be divided into 360 equal parts, all around its edge; then divide the same surface into seven sectors, in the proportion of the numbers above, by seven radii or lines drawn from the centre; next let the respective colours be painted in a lively manner on these spaces, but so as the edge of each colour may be made nearly like the colour next adjoining, that the separation may not be well distinguished by the eye; then if the top be made to spin, the colours will thus seem to be mixed all together, and the whole surface will appear of a uniform whiteness: and if a large round black spot be painted in the middle, so as there may be only a broad flat ring of colours around it, the experiment will succeed the better.

White bodies are found to take heat slower than black ones: because the latter absorb or imbibe rays of all kinds and colours, and the former reflect them. Hence it is that black paper is sooner inflamed, by a burning-glass, than white; and hence also black clothes, hung up in the sun by the dyers, dry sooner than white ones.

WHITEHURST, (John), in biography, an ingenious English philosopher, was born at Congleton in the county of Cheshire, the 10th of April 1713, being the son of a clock and watch-maker there. On his quitting school, where it seems the education he received was very defective, he was bred by his father to his own profession, in which he soon gave hopes of his future eminence.

At about the age of twenty-one, his eagerness after new ideas carried him to Dublin, having heard of an ingenious piece of mechanism in that city, being a clock with certain curious appendages, which he was very desirous of seeing, and no less so of conversing with the maker. On his arrival, however, he could neither procure a sight of the former, nor draw the least hint from the latter concerning it. Thus disappointed, he fell upon an expedient for accomplishing his design; and accordingly took up his residence in the house of the mechanic, paying the more liberally for his board, as he had hopes from thence of more readily obtaining the indulgence wished for. He was accommodated with a room directly over that in which the favourite piece was kept carefully locked up: and he had not long to wait for his gratification: for the artist, while one day employed in examining his machine, was suddenly called down stairs; which the young enquirer happening to overhear, softly slipped into the room, inspected the machine, and, presently satisfying himself as to the secret, escaped undiscovered to his own apartment. His end

thus compassed, he shortly after bid the artist farewell, and returned to his father in England.

About two or three years after his return from Ireland, he left Congleton and entered into business for himself at Derby, where he soon got into great employment, and distinguished himself very much by several ingenious pieces of mechanism, both in his own regular line of business, and in various other respects, as in the construction of curious thermometers, barometers, and other philosophical instruments, as well as in ingenious contrivances for water-works, and the erection of various larger machines: being consulted in almost all the undertakings in Derbyshire, and in the neighbouring counties, where the aid of superior skill, in mechanics, pneumatics, and hydraulics, was requisite.

In this manner his time was fully and usefully employed in the country, till, in 1775, when the act being passed for the better regulation of the gold coin, he was appointed stamper of the money-weights; an office conferred upon him, altogether unexpectedly, and without solicitation. Upon this occasion he removed to London, where he spent the remainder of his days, in the constant habits of cultivating some useful parts of philosophy and mechanism.

In 1778, Mr. Whitehurst published his Inquiry into the Original State and Formation of the Earth, of which a second edition appeared in 1786, considerably enlarged and improved; and a third in 1792. This was the labour of many years, and the numerous investigations necessary to its completion were in themselves laborious and of so intricate a nature as at times, though he was possessed of a strong constitution, not a little to prejudice his health. When he first entered upon this species of research, it was not altogether with a view to investigate the formation of the earth, but in part to obtain such a competent knowledge of subterraneous geography as might become subservient to the purposes of human life, by leading mankind to the discovery of many valuable substances which lie concealed in the lower regions of the earth.

May the 13th, 1779, he was elected and admitted a Fellow of the Royal Society. Before he was admitted a member, three several papers of his had been inserted in the Philosophical Transactions, viz. Thermometrical Observations at Derby, in vol. 57. An Account of a Machine for raising Water, at Oulton, in Cheshire, in vol. 65. And Experiments on Ignited Substances, vol. 66: which three papers were printed afterwards in the collection of his works in 1792.

In 1783, he made a second visit to Ireland, with a view to examine the Giant's Causeway, and other northern parts of that island, which he found to be chiefly composed of volcanic matter: an account and representation of which are inserted in the latter editions of his Inquiry. During this excursion he erected an engine for raising water from a well, to the summit of a hill, in a bleaching-ground at Tullidoi, in the county of Tyrone, which is worked by a current of water.

In 1787, he published An Attempt toward obtaining Invariable Measures of Length, Capacity, and Weight, from the Mensuration of Time. His plan is to obtain a measure of the greatest length that conveniency will permit, from two pendulums whose vibrations are in the ratio of 2 to 1, and whose lengths coincide nearly with the English standard in whole numbers. The numbers which he has chosen show much ingenuity. On a supposition that the length of a second's pendulum, in the latitude of London, is 39⅛ inches, the length of one vibrating 42 times in a minute, must be 80 inches; and of another vibrating 84 times in a minute, must be 20 inches; and their difference 60 inches, or five feet, is his standard measure. By the experiments, however, the difference between the lengths of the two pendulum rods, was found to be 59.[illegible]92 inches, instead of 60, owing to the error in the assumed length of the second's pendulum, 39⅛ inches being greater than the truth, which ought to be 39[illegible] very nearly. By this experiment, Mr. Whitehurst obtained a fact, as accurately as may be in a thing of this nature, viz. the difference between the lengths of two pendulum rods whose vibrations are known; a datum from whence may be obtained, by calculation, the true lengths of pendulums, the spaces through which heavy bodies fall in a given time, and many other particulars relating to the doctrine of gravitation, the figure of the earth, &c.

Mr. Whitehurst had been at times subject to small attacks of the gout, and he had for several years felt himself gradually declining. By an attack of that disease in his stomach, after a struggle of two or three months, it put an end to his laborious and useful life, on the 18th of February, 1788, in the 75th year of his age, at his house in

Bolt Court, Fleet Street, being the same house where another eminent self-taught philosopher, Mr. James Ferguson, had immediately before him lived and died.

WILKINS (Dr. JOHN), in biography, a very ingenious and learned English bishop and mathematician, was the son of a goldsmith at Oxford, and born in 1614. After being educated in Greek and Latin, in which he made a very quick progress, he was entered a student of New Inn in that university, when he was but thirteen years of age; but after a short stay there, he was removed to Magdalen Hall, where he took his degrees. Having entered into holy orders, he first became chaplain to William Lord Say, and afterwards to Charles Count Palatine of the Rhine, with whom he continued for some time. Adhering to the Parliament during the civil wars, they made him warden of Wadham College about the year 1648. In 1656 he married the sister of Oliver Cromwell, then lord protector of England, who granted him a dispensation to hold his wardenship, notwithstanding his marriage. In 1659, he was by Richard Cromwell made master of Trinity College in Cambridge; but ejected the year following, upon the restoration. He was then chosen preacher to the society of Gray's Inn, and rector of St. Lawrence Jewry, London, upon the promotion of Dr. Seth Ward to the bishoprick of Exeter. About this time he became a member of the Royal Society, was chosen of their council, and proved one of their most eminent members. He was afterwards made dean of Rippon, and in 1668 bishop of Chester; but died of the stone in 1672, at fifty-eight years of age.

Burnet writes, that "he was a man of as great a mind, as true a judgment, as eminent virtues, and of as good a soul, as any he ever knew; that though he married Cromwell's sister, yet he made no other use of that alliance, but to do good offices, and to cover the university of Oxford from the sourness of Owen and Goodwin. At Cambridge, he joined with those who studied to propagate better thoughts, to take men off from being in parties, or from narrow notions, from superstitious conceits, and fierceness about opinions. He was also a great observer and promoter of experimental philosophy, which was then a new thing, and much looked after. He was naturally ambitious, but was the wisest clergyman I ever knew. He was a lover of mankind, and had a delight in doing good."

Of his publications, which are all of them very ingenious and learned, and many of them particularly curious and entertaining; the first was in 1638, when he was only twenty-four years of age, viz. "The Discovery of a New World; or, a Discourse to prove, that it is probable there may be another Habitable World in the Moon; with a Discourse concerning the Possibility of a Passage thither." In 1640, "A Discourse concerning a New Planet, tending to prove that it is probable our Earth is one of the Planets." In 1641, "Mercury; or, the secret and swift Messenger; showing how a man may with privacy and speed communicate his thoughts to a friend at any distance;" 8vo. In 1648, "Mathematical Magic; or, the Wonders that may be performed by Mathematical Geometry;" 8vo. All these pieces were published entire in one volume, 8vo. in 1708, under the title of, "The Mathematical and Philosophical Works of the Right Rev. John Wilkins," &c. To this collection is also subjoined an abstract of a larger work, printed in 1668, folio, entitled, "An Essay towards a real Character and a philosophical Language."

WILL. In the Hartleyan acceptation of the term, the will is that state of mind which is immediately previous to, and causes, those express acts of memory, imagination, reasoning, or bodily motion, which we term voluntary; corresponding to the common acceptation of the term *volition*. In the more customary use of the term, it comprehends the whole class of feelings by which volition is produced, (for an account of which, see MENTAL PHILOSOPHY, §. 63—99).

It would be an interesting and very important inquiry, how far volition may become connected with, and regulate, the trains of thought and feeling, and the state of mind which we call attention; but this would lead us into a field which neither our limits of time, nor of space, would allow us to survey even cursorily. That such connection can be formed in various instances, there is no room for doubt; and were it otherwise, man would be merely the creature of external circumstances: that, on the other hand, there are limits to such establishment, is also indisputable; and were it not so, man might become the creator of his own mind, and all the benefits arising from the intellectual and social powers depend upon caprice. But we must content ourselves with laying before

our readers some of Hartley's valuable practical remarks respecting the will.

"The will appears to be nothing but a desire or aversion sufficiently strong to produce an action that is not automatic, primarily or secondarily (§. 101). The will is therefore that desire or aversion which is strongest for the present time; for if any other desire were stronger, the muscular motion connected with it by association would take place, and not that which proceeds from the will, or the voluntary one.

"Since the things which we pursue do, when obtained, generally afford pleasure, and those which we fly from affect us with pain, if they overtake us, it follows that the gratification of the will is generally associated with pleasure, the disappointment of it with pain. Hence a mere associated pleasure is transferred upon the gratification of the will; a mere associated pain, upon the disappointment of it: and if the will were always gratified, this mere associated pleasure would, according to the present frame of our natures, absorb, as it were, all our other pleasures; and thus, by drying up the source from whence it sprung, be itself dried up at last; and the first disappointments, after a long course of gratification, would be intolerable. Both which circumstances are sufficiently observable, in an inferior degree, in children that are much indulged, and in adults, after a long series of successful events. Gratifications of the will without the consequent expected pleasure, and disappointments of it without the consequent expected pain, are particularly useful to us here: and it is by this, amongst other means, that the human will is brought to a conformity with the divine; which is the only radical cure for all our evils and disappointments, and the only earnest and medium for obtaining lasting happiness.

"We often desire and pursue things which give pain rather than pleasure. Here it must be supposed that at first they afforded pleasure, and that they now give pain on account of the change in our nature and circumstances. Now, as the continuance to desire and pursue such objects, notwithstanding the pain arising from them, is the effect of the power of association; so the same power will at last reverse its own steps, and free us from such hurtful desires and pursuits. The recurrency of pain will at last render the object undesirable and hateful; and the experience of this painful process, in a few particular instances, will at last, as in other cases of the same kind, beget a habit of ceasing to pursue things, which we perceive by a few trials, or by rational arguments, to be hurtful to us on the whole.

"A state of desire ought to be pleasant at first, from the near relation of desire to love (§. 71), and of love, to pleasure and happiness; but in the course of a long pursuit, there intervene so many fears and disappointments, apparent or real, with respect to the subordinate means, and so many strong agitations of mind passing the limits of pleasure, as greatly to chequer a state of desire with misery. For a similar reason, states of aversion are chequered with hope and comfort."

WILL, *freedom of*. There are, perhaps, few topics of inquiry which have more than this perplexed the understandings and irritated the passions of mankind. From the continued conflict of opinion which has existed on the subject, in every age since the operations of the mind of man became a frequent subject of investigation, it might be almost presumed to belong to those questions which furnish abundant matter for discussion, but none for conviction; which sharpen ingenuity without resulting in certainty, and serve to display the human intellect in all its strength and weakness, in all its pride and humiliation.

Philosophical free-will, it must ever be remembered, is something totally different from external liberty. The latter is possessed by every man who has the power of doing as he pleases; that is, of carrying his volitions into execution. But whether volitions be free or necessitated; whether, in forming these, the mind exert a self-determining power, or be uniformly and irresistibly influenced by motives, is a question perfectly unconnected with the circumstances of freedom or control relating to their execution. The will may be bound, though the consequent act be unimpeded; and, on the other hand, the exercise of the self-determining power, in volition, may be prevented, by numberless restraints, from being followed up in act. The point in discussion between the advocates of philosophical free-will and their opponents is, whether man be invariably and necessarily influenced by motives; or, whether he possess a self-governing, self-determining power, which he may exert by acting either according to motives, in opposition to motives, or without any motives at all. And though some of the defenders of liberty differ from others in the extent of the exer-

cise of this power, many limiting it to acts of mere deliberation, and others connecting it with every actual and possible instance of volition, the controversy between them and the necessarians has no reference to these differences, but is circumscribed by the single question, whether, in any case whatever, a volition can originate independently of motive; or, in other words, whether the mind be capable of acting differently, previous circumstances continuing in every respect the same. In support of philosophical liberty, its supporters make their first appeal to consciousness. With respect to various volitions, it is observed, we are not only insensible to an overpowering and resistless influence of motives, but are positively conscious of choosing without any motive, and often, even in opposition to the strongest. And were it not that the mind possessed this paramount and independent faculty—this liberty of determining differently in the same circumstances, whence could arise those feelings of approbation or blame, which ever attach to volitions of high importance and moral consequence? Could censure reasonably be applied to any act that was inevitable? or is there any adequate ground of applause for what could not possibly have been unperformed? Are not the feelings of individuals, and the consent of nations, on this subject, perfectly decided and coincident? The repentant sinner is overwhelmed with remorse for that delinquency which he feels it was no less within his power than his duty to have avoided: the abandoned criminal, who has lifted his murderous arm against his neighbour, falls an unpitied victim to the laws of his country. Upon what principle is remorse felt in the one case, and execution inflicted in the other, but on that which naturally presses conviction on every human bosom, that the offender, instead of being hurried on to guilt by irresistible destiny, was merely the ready tool of appetites which he might have controuled; the willing slave of passions which he might have corrected. The lunatic incendiary is regarded as no proper object of punishment, frenzy having usurped the throne of reason, and the exercise of rational free-will being precluded by the paroxysm of disease. And, on similar grounds, the destroyer of life by mere accident, is exempt from the vengeance of human laws, which point their thunder only against those who are both capable of distinguishing right from wrong, and of avoiding the crimes into which they voluntarily plunge themselves. If, therefore, any conclusion whatever can be justly inferred from the almost instinctive feelings of mankind, which even those uniformly act upon who systematically controvert and ridicule them, how powerful must the argument, hence derived, be considered in favour of that liberty of will, without which the agonies of remorse appear only the gratuitous self-inflictions of folly; and the most essential acts of legislation, seem the most execrable operations of tyranny? The moral and religious consequences, considered as arising from the system of necessity, are regarded by the advocates for free-will as of a nature so repulsive to the interests of virtue, so incompatible with moral discipline, so full of palpable absurdity and extreme impiety, that these alone are deemed sufficient to justify the rejection of a doctrine, from which they appear essentially and decidedly to flow. Can that system, it is asked, be true, which saps the foundations of virtue, by ascribing every act and thought, every feeling and wish, connected with moral character, to imperious and resistless impulse? which constitutes man a mere machine, guiltless even in the extreme of wickedness, and worthless in the maturity of benevolence; because in both cases, equally compelled by circumstances to good or evil, and equally destitute of moral quality with the quickening sun or the devouring tempest? If every sentiment and deed of every human individual be the result of preceding situations, which situations themselves are only links in an interminable series of processes, equally compelled and necessitating, how vain are all the popular and presumed means of operating upon the mind, to reclaim from vice, or guide to virtue? Can there be any stimulus to exertions decidedly fruitless? or can there be any penitence for inevitable crime? or can there be any justice, human or divine, in the punishment of offences committed, indeed, by choice, yet committed through necessity? With what disgust will be viewed the imputation thrown by this system on the Supreme Being (who is considered by it to be not only the sovereign, but the sole agent, in the universe), as the origin of all existing evil! Under what character is the Divine Being represented by this doctrine, but under that of a baffling tyrant, and a deriding fiend; exhorting men to what they cannot accomplish, and torturing them for what they cannot avoid, and, under the designation of

the God of truth, uttering a tissue of the most malignant falsehoods? With what horror must we contemplate a Deity, who is exhibited as the very author of what he professes to hate, the performer of what he punishes, and the source of every polluted thought, every tormenting passion, and every evil work; whose chosen instruments and objects appear to be, hatred and uncharitableness, guilt and terror, confusion, pain, and death; who is displayed, in short, as the introducer of all moral evil, and the scourge of all moral nature?

It is by no means surprising that observations, or arguments, such as these, should have operated strongly on the majority even of persons in some degree habituated to reflection. The moral man has trembled for the interests of virtue; the pious man has recoiled from the dreaded charge of blasphemy; and so coincident is the misapprehended system of liberty with the feelings of indiscriminating and unreflecting minds, that it would be truly extraordinary if the opposite doctrine had not to encounter from such, prejudices the most violent and hostile. General consent, however, and presumed consciousness, are no more sufficient to establish the doctrine of philosophical free-will, than the appearance exhibited by the sun and stars of revolving round this terraqueous globe, and the universal conviction once entertained of the reality of this appearance, can be considered to have been irrefragable evidence of this popular philosophy. And with regard to the interests of virtue, and even the honour of the Deity, the man who refrains from the discussion of important topics, from a trembling apprehension lest these should be injuriously involved in the result of his investigation, displays inexpressibly more of fastidious sensibility than of vigorous intellect. If discussion can possibly evince that virtue is detrimental or worthless, instead of being extolled as the best source of hope, and the only guide to happiness, let it be instantly exposed to the aversion and avoidance of mankind. And if the most acute and profound speculation can possibly disconnect from the Supreme Being those qualities of wisdom and goodness, of power and perfection, which have hitherto only appeared the more clearly to belong to him the more his attributes have been investigated, let the veil be, at once, rent from the imagined sanctuary, and let detestation or contempt be substituted for joyful devotion and humble imitation. These delicate scruples, and fearful doubts, and awful hesitations, have too long retarded the march of the human mind in its pursuit of the ends and means most worthy of its researches. They have been in every age supports, as, indeed, they are results, of superstition: they have aided the views of civil tyranny, and inquisitorial bigotry; and until the operations of thought be unimpeded by these morbid tremors, any rapid advance to the maturity of social institutions can be expected only in vain. In opposition, then, to the doctrine of free-will, so tenaciously maintained and so ardently advocated, it may be observed, that upon the only sound principles of philosophy, upon the very basis of all human speculation and conclusion, the imagined liberty of man will appear equally unsupportable, as any change in the arrangements of material nature without a corresponding change of pre-existing circumstances. If volitions, in any case, start up in the mind uncaused, as well may it be presumed, that the universal system of nature sprang into existence without any previous and operative energy. All inquiry into causes is vain; all reference to circumstances is absurd: conclusions the most opposite may with equal propriety be inferred from the same premises; or rather, the only conclusion to be formed is, that of one immense and universal chaos, in which processes, both of mind and matter, are incipient without cause, and operative without effect. If, on the other hand, man be uniformly and imperiously influenced by motives, volitions are as definitive, in definite circumstances, as the movements of palpable mechanism; and the determinations of the mind are equally decided and inevitable, as the inclinations of the balance. The most animated display of evils, imagined to result from the system of necessity, will scarcely induce any vigorous and unprejudiced mind to surrender the only basis on which inference can be formed and inquiry instituted. But the principles of religion are equally adverse to free-will with the axioms of philosophy; and it is curious to observe, that the doctrine of liberty, under consideration, meets with its destruction in what may be regarded, possibly, as the very source of its existence. Sentiments of religion, unquestionably, suggested the expediency of human freedom, to screen the character of Deity from imputation on the ground of natural and moral evil; and man was thus invested with a paramount and

mysterious faculty, by which, in circumstances precisely the same, he is capable of performing any action, or its opposite. By a fallacy, more reverential than ingenious; by a sophism, such as in ordinary life would expose its employers to instant detection and ridicule, this pre-eminent power, though admitted to be communicated, is considered as the efficient cause of all that evil which it was regarded indecorous and blasphemous to ascribe to Deity. The responsibility on this subject, which was conceived to reflect severely on the character of God, by this accommodating invention, was imagined to be easily and happily removed. But if piety has, upon this curious ground, contributed to establish the belief in human free-will, it has no less decidedly maintained the doctrine of divine omniscience: yet to unite these articles in the same creed, must be regarded by the unbiassed enquirer as absolutely and eternally impossible. How can it be within the power of man to avoid doing what God foresees he will perform? or how can that remain undone which is foreknown, and unquestionably, therefore, certainly will be accomplished? What becomes of that boasted liberty, which is incapable of being exerted, and the exercise of which, though strangely denied to be precluded by necessity, it must be at least admitted, has to encounter the most indubitable and decided certainty? And how is the difficulty which, on every other system, presses from the consideration of existing evil, at all mitigated by an hypothesis, which merely transfers the charge from the principal to the agent; from the Creator to the creature; from the bestower of the faculty of freedom, who must be aware of all its possible applications and consequences, and who therefore, in the eye of reason, intends all the effect, of the principle he thus communicates, to the frail possessor and foreseen abuser of it? With respect, moreover, to moral discipline, how can any system, which has this object in view, be at all applicable to beings, whose merit and perfection are supposed to consist in a total superiority to motive; who can resist the strongest applications of menace or conciliation, of remuneration or penalty; with whom caprice alone is principle, and chance direction; and an indefinable, unintelligible power of self-determination, without the aid of motive, or even in diametrical opposition to the strongest, is the substitute for all steady object and rational inducement? With regard to virtue, in this system, its maturity consists not in useful tendencies and affections, so confirmed by habit as to have acquired almost an incapability of effectual counteraction, a definition founded on the only correct theory of the human mind, and which presents the most admirable and impressive lessons of morality, but in an imagined principle or faculty which has no perceivable connection with character, habit, or affection; and in proportion to the degree in which any intelligent agent can be supposed to act from this unmotived faculty, in that proportion must he be presumed less capable of forming those fixed and almost indestructible associations which are the sole security of moral excellence. Free-will, then, thus appears to be in irreconcileable hostility with the fundamental principle of human discussion and investigation, on every subject moral or material, that every thing which begins to be must have a cause: its complete operation excludes man from the possibility of virtuous habits, as these can result solely from his definite impressibility by definite circumstances: it prevents any consistent application of threats or exhortation, of reward or punishment; because, to a mind unguided and ungovernable by motive, these are equally useless as expostulation with a storm, or advice to a conflagration. Finally, from the character of God it snatches that attribute, without which Providence must be supposed to be any thing rather than what the term naturally implies. Instead of a superintending Deity, foreseeing every event, affected by no surprize, and subject to no disappointment, we are presented with a governor at the helm of Nature, who, in the impressive language of scripture, knows not what a day may bring forth: his arrangements may be frustrated by human folly; his happiness may be impaired by human hostility: man, that is a worm, may baffle the views of Divine intelligence, and counteract the energies of Almighty power!

Will and Testament, is that disposition of property which is made by a person, to take place after his decease. Every person capable of binding himself by contract, is capable of making a will.

Also a male infant of the age of fourteen years and upwards, and female of twelve years or upwards, are capable of making a will respecting personal estates only. But a married woman cannot make a will, unless a power be reserved in a marriage settlement; but wherever personal property, however, is given to a married woman, for

her sole and separate use, she may dispose of it by will.

If a feme sole make her will, and afterwards marry, such marriage is a legal revocation of the will. Wills are of two kinds, written and verbal; the former is most usual and secure.

It is not absolutely necessary that a will should be witnessed; and a testament of chattels, written in the testator's own hand, though it have neither the testator's name nor seal to it, nor witnesses present at his publication, will be good, provided sufficient proof can be had that it is his hand writing. By statute 29 Charles II. c. 3, all devises of lands and tenements shall not only be in writing, but shall also be signed by the party so devising the same, or by some other person in his presence, and by his express direction, and shall be witnessed and subscribed in the presence of the person devising, by three or four credible witnesses, or else the devise will be entirely void, and the land will descend to the heir at law.

A will, even if made beyond sea, bequeathing land in England, must be attested by three witnesses.

A will, however, devising copyhold land, does not require to be witnessed; it is sufficient to declare the uses of a surrender of such copyhold land made to the use of the will. The party to whom the land is given becomes entitled to it by means of the surrender, and not by the will.

A codicil is a supplement to a will, or an addition made by the person making the same, annexed to, and to be taken as part of the will itself, being for its explanation or alteration, to add something to, or take something from, the former disposition, and which may also be either written or verbal, under the same restrictions as regard wills.

If two wills are found, and it does not appear which was the former or latter, both will be void; but if two codicils are found, and it cannot be ascertained which was the first, but the same thing is devised to two persons, both ought to divide; but where either wills or codicils have dates, the latter is considered as valid, and revokes the former. See ADMINISTRATOR, EXECUTOR, LEGACY.

WILLICHIA, in botany, so named in honour of Christ. Lud. Willich, a genus of the Triandria Monogynia class and order. Essential character: calyx four-cleft; corolla four-cleft; capsule two-celled, many-seeded. There is only one species; *viz.* W. repens, found by Mutis in Mexico.

WILLUGHBEIA, in botany, so named in memory of Francis Willughby, F.R.S. a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Apocineæ, Jussieu. Essential character: contorted; corolla salver-shaped; stigma headed; fruit a one or two-celled berry like a pumpkin. There are two species; *viz.* W. acida and W. scandens, both natives of Guiana.

WIND. See METEOROLOGY.

WIND *gage*, in pneumatics, an instrument serving to determine the velocity and force of the wind. See ANEMOMETER, ANEMOSCOPE.

Dr. Hales had various contrivances for this purpose. He found, that the air rushed out of a smith's bellows at the rate of 68¾ feet in a second of time, when compressed with a force of half a pound upon every square inch lying on the whole upper surface of the bellows. The velocity of the air, as it passed out of the trunk of his ventilators, was found to be at the rate of 3,000 feet in a minute, which is at the rate of 34 miles an hour. The same author says, that the velocity with which impelled air passes out at any orifice, may be determined by hanging a light valve over the nose of a bellows, by pliant leathern hinges, which will be much agitated and lifted up from a perpendicular, to a more than horizontal position, by the force of the rushing air.

M. Bouguer contrived a simple instrument, by which may be immediately discovered the force which the wind exerts on a given surface. This is a hollow tube A A, B B, (Plate XVI. Miscel. fig. 13) in which a spiral spring, C D, is fixed, that may be more or less compressed by a rod F S D, passing through a hole within the tube at A A. Then having observed to what degree different forces or given weights are capable of compressing the spiral, mark divisions on the rod in such a manner, that the mark at S may indicate the weight requisite to force the spring into the situation, C D: afterwards join at right angles to this rod at F, a plane surface, C F F, of any given area at pleasure; then let this instrument be opposed to the wind, so that it may strike the surface perpendicularly, or parallel to the rod; then will the mark at S show the weight to which the force of the wind is equivalent.

The following Table will give the different velocities and forces of the wind, according to their common appellations.

Velocity of the wind. Miles in one hour.	= feet in one second.	Perpendicular force on one sq. foot, in averdupois pounds.	Common appellations of the wind.
1	1.47	.005	Hardly perceptible.
2	2.93	.020	Just perceptible.
3	4.40	.044	
4	5.87	.079	Gentle pleasant wind.
5	7.33	.123	
10	14.67	.492	Pleasant brisk gale.
15	22.00	1.107	
20	29.34	1.968	Very brisk.
25	36.67	3.075	
30	44.01	4.429	High winds.
35	51.34	6.027	
40	58.68	7.873	Very high.
45	66.01	9.963	
50	73.35	12.300	A storm or tempest.
60	88.02	17.715	A great storm.
80	117.36	31.490	A hurricane.
100	146.70	49.200	A hurricane that tears up trees, and carries buildings, &c. before it.

The force of the wind is nearly as the square of the velocity, or but little above it, in these velocities. But the force is much more than in the simple ratio of the surfaces, with the same velocity, and this increase of the ratio is the more, as the velocity is the more. By accurate experiments with two planes, the one of 17¾ square inches, the other of 32, which are nearly in the ratio of 5 to 9. Dr. Hutton found their resistances, with a velocity of 20 feet per second, to be the one, 1.196 ounces, and the other, 2.542 ounces; which are in the ratio of 8 to 17, being an increase of between one-fifth and one-sixth parts more than the ratio of the surfaces.

WINDLASS, a machine used to raise heavy weights withal, as guns, stones, anchors, &c. It is very simple, consisting only of an axis, or roller, supported horizontally at the two ends, by two pieces of wood and a pulley: the two pieces of wood meet at top, being placed diagonally, so as to prop each other; the axis, or roller, goes through the two pieces, and turns in them. The pully is fastened at top where the pieces join. Lastly, there are two staves or handspikes go through the roller, whereby it is turned, and the rope which comes over the pulley is wound off and on the same.

Windlass, in a ship, is an instrument in small ships, placed upon the deck, just abaft the foremast. It is made of a piece of timber six or eight feet square, in form of an axle-tree, whose length is placed horizontally upon two pieces of wood at the ends thereof, and upon which it is turned about by the help of handspikes put into holes made for that purpose. This instrument serves for weighing anchors, or hoisting of any weight, in or out of the ship, and will purchase much more than any capstan, and that without any danger to those that heave; for if in heaving the windlass about, any of the handspikes should happen to break, the windlass would pall of itself.

WINDMILL, a kind of mill, the internal parts of which are much the same with those of a water-mill; from which, however, it differs, in being moved by the impulse of the wind upon its vanes or sails, which are to be considered as a wheel on the axle. Plate, Windmill, is a vertical section of a windmill of that kind, which is called a smock-mill, i. e. when the building, the mill, and machinery are fixed, and the head of the mill supporting the axis of the sails turns round upon it. A A are the walls of the mill-house, which is longer one way than the other, and the section is through the shortest side; in this direction it will but just contain the machinery, and leave a passage; in the other direction the house is longer, and is used as a warehouse to stow the corn and flour. The roof of the house is framed of large beams, a flooring is laid on these beams, and then the whole is covered with sheet lead. Eight long upright beams, B B, are framed into the roof of the house, and disposed round in a circle; at the upper angle they support a circular kirb, D D; the eight uprights, B B, are braced by cross pieces framed between them, so as to render the whole building very staunch; the outside is covered with weather-board, just to shoot off the rain, but open enough to admit the wind to pass freely through the house. Upon the upper fixed kirb, D D, thirty-six rollers are placed (two of them are seen in the section); these rollers turn in mortices, cut through a circular ring of wood, which keeps the thirty-six rollers in their places, and at their proper distances from one another. The rollers support another circular wooden ring, *a a*, on which the head of the mill is framed. This framing consists of two beams, *b*, halved into the ring, parallel to the main axis of the sails, and including the great cog wheel between

them, only one of them is shown in the figure, the other being taken away in the section. Two cross beams, *d* and *e*, bolted upon *b b*, supports the bearings for the main axis, and another cross beam, *f*, bolted to the underside of *b*, to sustain the upper bearing for the vertical axis.

We now come to speak of the machinery: H H, are two of the four sails seen edgeways; the broad part of the sails, which is covered with cloth, is set oblique to the plane of the sails motion, and the axis of the sails is set in the direction of the wind; it is by the action of the wind upon the oblique sail, that it is made to revolve on its axis; the wind acts constantly as a wedge upon the sails, and thus drives them round. The four sails are firmly bolted to an iron cross, *e*, cast in one piece with the main: *a b c d e f g* is a wooden pole fixed on at the intersection of the four sails, and forming a continuation of the axis; four ropes are extended from the end of the pole to the end of the sails, and hauled tight by a block of pulleys, by these the sails are stiffened, and prevented from bending by the action of the wind upon them: *h* is the main cog wheel, fixed upon the iron axis, and turning round with it; it has a flexible ring of wood, composed of five segments, and jointed together by iron hinges and compassing it; one end of this ring of wood, called the brake, is fastened by a joint to the under side of the beam, *b*; the other end comes round nearly to the same point, and is fastened to a long lever, *i*, called the brake lever. When this lever is lifted up, the brake is lifted off from the wheel, and does not touch it on any part, and the wheel and sails can turn; but when the lever is suffered to fall down, the brake closes round the wheel, and prevents the wheel and sails from turning. The brake lever is lifted up by a rope, *k*, which hangs down in reach of the miller when standing on the stage, I I, built round the mill for the purpose, as also for clothing or unclothing the sails. When the brake is to be held up for any length of time, while the mill is at work, the brake rope is hooked on a hook driven into one of the uprights, B B. The head of the mill can be turned round upon the thirty-six rollers, to set the sail round in the proper direction to meet the wind. The fixed kirb, D D, has a ring of cogs all round its outside, which work with a pinion on a spindle, *l*, turning in a socket fixed by iron braces. To the moveable head of the mill, on the upper end of the spindle, *l*, a crown wheel is fixed, which is turned by a small pinion on the same spindle, with a wheel, *m*, round which an endless rope runs, and which hangs down in reach of the miller when on the stage, I. By pulling down one side of the endless rope he turns the wheel, *m*, and by the pinion the crown wheel, and its pinion, which acting against the teeth in the kirb, D, turns the head round upon the thirty-six rollers, and puts the sails in any position according to the wind: *o* is a roller turning upon an iron pin fastened to the under side of the beam, *b*, and acting against the inside of the kirb; another similar roller is fixed to the other beam, which is parallel to *b*; their use is to keep the head steady upon the rollers, otherwise the head might be thrown backwards by the action of the wind upon the sails. The upper part of the head is light framing and thin boards, covered with copper just to exclude the rain. The main cog-wheel, *h*, turns a trundle, K, on the upper end of a long vertical shaft, L L, which comes down to the ground, and turns in a socket supported on masonry at M: *p* is a crown wheel of fifty-six teeth turning another wheel of seventeen teeth on horizontal, which has riggers, *g*, on it to turn bolting mills and dressing machines in the upper room. In the lower room a large spur-wheel, *t*, of seventy-two teeth, is fixed, and turns a nut on each side of it, one of twenty-eight, the other of twenty-six teeth, on the spindles of their respective millstones, *r* and *s*.

The construction of the mill for grinding flour is well explained in the article MILL, to which we refer our readers.

WIND *sails*, in a ship, are made of the common sail cloth, and are usually between twenty-five and thirty feet long, according to the size of the ship, and are of the form of a cone ending obtusely: when they are made use of, they are hoisted by ropes to about two-thirds or more of their height, with their bases distended circularly hoops, and their apex hanging downwards in the hatchways of the ship; above each of these one of the common sails is so disposed, that the greatest part of the air rushing against it, is directed into the wind-sail, and conveyed, as through a funnel, into the upper parts of the body of the ship.

WINDAGE *of a gun*, the difference between the diameter of the bore, and the diameter of the ball.

WINE. See FERMENTATION, &c. All

wines contain an acid, alcohol, tartar, extract, aroma, and a colouring matter. The presence and nature of each of these principles may be ascertained in the following way. 1. Acid. All wines, even the softest and mildest, redden litmus, and therefore contain an acid. This abounds however chiefly in the thin wines of wet and cold climates, where the grape juice or must contains but a small portion of sugar. When wine has been boiled to extract the brandy, the liquor that remains in the still, and is thrown away as useless, is a sour nauseous fluid with an acrid and burnt flavour. When filtered and allowed to remain at rest for a time, it deposits a good deal of extractive matter, becomes covered with mould, and then contains a notable quantity of acetous acid, which may be separated by distillation. The acid is however not entirely acetous, at least not till after standing a considerable time, for it precipitates and forms an insoluble salt with lime water, and with the soluble salts of silver, lead, and mercury, and appears to be the malic acid mixed with a little citric, both of which are converted into vinegar by spontaneous decomposition. The wines that contain the greatest quantity of these acids yield the worst brandy, nor is there any method yet known of separating or neutralizing the acid without materially injuring the quality, or lessening the quantity of the ardent spirit. 2. Alcohol. The existence of this principle and mode of extraction by distillation has been fully described under the article brandy. The quantity of alcohol varies prodigiously. The strong, rich, full-bodied wines of the warmer vine countries will yield as much as a third of ardent spirit; whilst the thin light wines will often give no more than about one-sixteenth of the same strength. 3. Tartar. This substance has also been fully described in its proper place. Tartar is not altogether a product of the fermentation of wine, since it is contained in must, though in small quantity. 4. Extract. Must contains an abundance of extractive matter, which materially assists the fermentation, and is afterwards found, in part at least, in the lees, but another portion may be obtained from the wine by evaporation. It is also extract that mixes with and colours the tartar. By age the quantity of extractive matter diminishes. 5. Aroma. All wines possess a peculiar and grateful smell, which would indicate a distinct aromatic principle, but it has never been exhibited in the form of essential oil, or condensed in any smaller quantity by distillation or any other mode. To give wine all its aroma it should be fermented very slowly. 6. Colouring matter. The husk of the red grape contains a good deal of colour, which is extracted when the entire fruit is pressed, and becomes dissolved in the wine when the fermentation is complete. Many substances will separate the colour. If lime-water is added to high-coloured wine a precipitate is formed of malat of lime that carries down with it all the colouring matter, which cannot again be separated either by water or alcohol. But if wine alone is evaporated gently to dryness, and the residue treated with alcohol, the colouring matter dissolves therein. We may add too, that the natural colour of wine is entirely and speedily destroyed by the addition of hot well-burnt charcoal in pretty fine powder. The colour of red wine in the state in which we receive it is not entirely that of the grape, but is given by other colouring substances, which however are quite innoxious.

WINGED, in botany, a term applied to such stems of plants as are furnished all their length with a sort of membranaceous leaves, as the thistle, &c. Winged leaves, are such as consist of divers little leaves, ranged in the same direction, so as to appear only as the same leaf. Such are the leaves of agrimony, acacia, ash, &c. Winged seeds, are such as have down or hairs on them, which, by the help of the wind, are carried to a distance.

WINGS, in heraldry, are borne sometimes single, sometimes in pairs; in which case they are called conjoined. When the points are downward, they are said to be inverted; when up, elevated.

WINGS, in military affairs, are the two flanks or extremes of an army, ranged in form of a battle; being the right and left sides thereof.

WINGS, in fortification, denote the longer sides of horn-works, crown-works, tenailles, and the like out-works; including the ramparts and parapets, with which they are bounded on the right and left from their gorge to their front.

WINTERA, in botany, so named from Captain William Winter, who brought the bark of this tree from the Straits of Magellan, a genus of the Polyandria Tetragynia class and order. Natural order of Magnoliæ, Jussieu. Essential character: calyx three-lobed; petals six or twelve; germs

club-shaped; styles none; berries four or eight, obovate. There are three species.

WIRE *drawing*, the art of drawing out long bars of metal, by pulling it through holes in a plate of steel, or other fit metallic compound. In order that a wire may be drawn, it is requisite that the metal should have considerable tenacity. Gold, silver, iron, steel, copper, and their compounds, are most commonly used in the arts. The process is of considerable simplicity. A number of holes, progressively smaller and smaller, are made in a plate of steel, and the pointed end of a bar of metal being passed through, one of them is forcibly drawn by strong pinchers, so as to elongate it by the pressure arising from the re-action of the greased hole: this is the wire; and it is again passed in like manner through another hole a little smaller; and, by continuing the process, the wire has its length increased, and its diameter diminished, to a very great degree. The largest wire may be nearly an inch in diameter, and the smallest we have seen was about one-thousandth part of an inch; but we are assured, that silver wire has been made one-fifteen-hundredth of an inch in diameter. The size of these small wires may be ascertained from the weight of a known measure of length, and the specific gravity of the metal. Or, less correctly, the wire may be wound round a pin, and the number of turns counted which make a given length.

Wires are drawn square, and of other figures in their sector. In particular they are drawn grooved, so that any small part will form the pinion of a clock or watch work.

As the violent action of the drawing plate renders the wire hard and brittle, it is necessary to anneal it several times during the course of drawing. Very small holes are made by hammering up the larger, and the point, in very thin wire, is made by rolling or crushing the end by a smooth burnishing tool upon a polished plate.

It is said that soft steel is as good for the wire-drawer's plate as that which is hard, or as the compound material which comes from France in wire plates, and is highly esteemed. This has not been yet chemically examined.

WIRE *of Lapland*. The inhabitants of Lapland have a sort of shining slender substance in use among them on several occasions, which is much of the thickness and appearance of our silver wire, and is therefore called, by those who do not examine its structure or substance, Lapland wire. It is made of the sinews of the rein-deer, which being carefully separated in the eating, are by the women, after soaking in water, and beating, spun into a sort of thread, of admirable fineness, and strength, when wrought to the smallest filaments; but when larger, is very strong, and fit for the purposes of strength and force. Their wire, as it is called, is made of the finest of these threads, covered with tin. The women do this business, and the way they take is to melt a piece of tin, and placing at the edge of it a horn with a hole through it, they draw these sinewy threads, covered with the tin, through the hole, which prevents their coming out too thick covered. This drawing is performed with their teeth: and there is a small piece of bone placed at the top of the hole, where the wire is made flat, so that we always find it rounded on all sides but one, where it is flat. This wire they use in embroidering their clothes as we do gold and silver; they often sell it to strangers, under the notion of its having certain magical virtues.

WIT, a faculty of the mind, consisting, according to Mr. Locke, in the assembling and putting together of those ideas, with quickness and variety, in which any resemblance or congruity can be found, in order to form pleasant pictures and agreeable visions to the fancy. This faculty, the same author observes, is just the contrary of judgment, which consists in the separating carefully from one another, such ideas wherein can be found the least difference, thereby to avoid being misled by similitude and affinity, to take one thing for another. It is the metaphor and allusion, wherein, for the most part, lies the entertainment and pleasantry of wit, which strikes so lively on the fancy, and is therefore so acceptable to all people, because its beauty appears at first sight, and there is required no labour of thought to examine what truth or reason there is in it. The mind without looking any further, rests satisfied with the agreeableness of the picture, and the gaiety of the imagination; and it is a kind of affront to go about to examine it by the severe rules of truth or reason. Wit is also an appellation given to the person possessed of this faculty; and here the true wit must have a quick succession of pertinent ideas, and the ability of arranging and expressing them in a lively and entertaining manner; he must at the same time have a great deal of energy and delicacy in his sen-

timents; his imagination must be sprightly and agreeable, without any thing of parade or vanity in his discourse: but it is not, however, essential to the character of a wit, to be ever hunting after the brilliant, studying sprightly turns, and affecting to say nothing but what may strike and surprise.

WITENA-*mot*, or WITENA *gemot*, among our Saxon ancestors, was a term which literally signified the assembly of the wise men, and was applied to the great council of the nation, of latter days called the parliament.

WITHERINGIA, in botany, so named in honour of William Withering, M. D. F. R. S. a genus of the Tetrandria Monogynia class and order. Natural order of Luridæ. Solaneæ, Jussieu. Essential character: corolla subcampanulate, with four bumps in the tube; calyx very small, indistinctly four-toothed; pericarpium two-celled. There is only one species; *viz.* W. solanacea, a native of South America.

WITHERITE, in mineralogy, a species of the genus Barytes: it is commonly of a light yellowish grey colour, usually massive, but sometimes crystallized: specific gravity about 4.3. It melts without addition before the blow-pipe into a white enamel. It dissolves with effervescence in acids: it consists, according to Klaproth, of

Carbonate of barytes....	98.246
Carbonate of strontian ..	1.703
Alumina with iron........	0.043
Carbonate of copper....	0.008
	100.000

But, according to other chemists, it consists of

Barytes..................	74.5
Carbonic acid..........	25.5
	100.0

It occurs in veins, heavy spar, lead glance, blende, and calamine, and is found in Lancashire. It is a very active poison; but combined with muriatic acid it may be used with great caution in cases of scrophula.

WITNESS, in law, one who is sworn to give evidence in a cause. If a man be subpœnaed as a witness upon a trial, he must appear in court on pain of 100*l.* to be forfeited to the king, and 10*l.* together with damages equivalent to the loss sustained by the want of his evidence to the party aggrieved. But witnesses ought to have a reasonable time, that their attendance upon the court may be of as little prejudice to themselves as possible; and the Court of King's Bench held, that notice at two in the afternoon to attend the sitting that evening at Westminster was too short a time.

Where a witness cannot be present at a trial, he may, by consent of the plaintiff and defendant, or by rule of court, be examined upon interrogatories at the judge's chambers. No witness is bound to appear to give evidence in a cause unless his reasonable expense be tendered him; and if he appear, till such charge is actually paid him, except he both resides and is summoned to give evidence within the bills of mortality. See ARREST, EVIDENCE, PRIVILEGE.

WITSENIA, in botany, a genus of the Triandria Monogynia class and order. Natural order of Ensatæ. Irides, Jussieu. Essential character: corolla one-petalled, cylindrical, six-parted; stigma emarginate; capsule superior. There is only one species: *viz.* W. maura, a native of the Cape of Good Hope.

WOAD. See ISATIS.

WOLF. See CANIS.

WOLFRAM, in mineralogy, is a species of stone of an intermediate colour between dark-greyish black and brownish black, sometimes inclining to velvet black. It occurs massive and also crystallized: specific gravity somewhere between 6 and 7. It decrepitates before the blow-pipe, and is infusible even with borax. Specimens have been analysed by several chemists: according to Klaproth and Vauquelin it consists of

	Klaproth.
Molybdic acid...............	46.9
Oxide of iron.................	31.2
Loss............................	21.9
	100.0

	Vauquelin.
Molybdic acid..........	67.00
Oxide of manganese...	6.25
Oxide of iron...........	18.00
Silica......................	1.50
Loss........................	7.25
	100.00

It occurs in primitive mountains, and in the oldest formations. It is usually accompanied with tin, and distinguished from tin-stone by its streak, which is reddish brown, whereas that of tin-stone is grey. See TIN.

WOOD. See TIMBER. The wood of

vegetables consists of fibres, impregnated with a variety of the natural juices of the plant, as mucilage, resin, colouring matter, extract, essential oil, sugar, &c. All of these may be obtained from one or other kind of wood, by applying those menstrua which dissolve these substances in their natural state. If a piece of wood be boiled in a great quantity of water, till it no longer gives out taste or smell, and if it be afterwards digested in alcohol, the substance which remains is the woody fibre. It is either in a fibrous, lamellated, or pulverulent form. This substance, which is more or less coloured, has neither taste nor smell; is not altered by exposure to the air; and is insoluble in water and alcohol. When it is heated in contact with air, it blackens, exhales dense, acrid, pungent fumes, and leaves behind a coaly matter, which does not change its form. By reducing it to ashes, it is found to contain a little potash, sulphate of potash and lime, and phosphate of lime. When it is distilled in a retort it yields water, acetic acid contaminated with oil, a thick oily matter, carbonated hydrogen, and carbonic acid gases, and a portion of ammonia, combined with acetic acid. The pure ligneous fibre is decomposed by being heated with strong nitric acid, and yields a very considerable quantity of oxalic and malic acid. The surface of wood is readily stained by a variety of substances; and if these are allowed to remain in contact with it, they sink into the substance of the wood, which often produces a very agreeable effect in cabinet work.

Wood, *cutting in*, is used for various purposes; as for initial and figured letters, head and tail-pieces of books; and even for schemes, mathematical and other figures, to save the expense of engraving on copper: and for prints, and stamps for papers, calicoes, linens, &c. The invention of cutting in wood, as well as that in copper, is ascribed to a goldsmith of Florence; but Albert Durer and Lucas brought both these arts to perfection. About two hundred years ago, the art of cutting in wood was carried to a very great pitch, and might even vie, for beauty and justness, with that of engraving on copper: at present it is much neglected, the application of artists being wholly employed on copper, as the more easy and promising province: not but that wooden cuts have the advantage of those in copper in many respects; chiefly for figures and devices in books; as being printed at the same time and in the same press with the letters: whereas, for the other, there is required a particular and separate impression. The cutters in wood begin with preparing a plank or block of the size and thickness required, and very even and smooth on the side to be cut: for this they usually take pear-tree, or box; but the latter is best, as being closest, and least liable to be worm eaten. On this block they draw their design with a pen or pencil, exactly as they would have it printed; or they fasten the design drawn on paper upon the block with paste and a little vinegar, the strokes or lines turned towards the wood. When the paper is dry, they wash it gently with a sponge dipped in water, and then take it off by little and little, rubbing it first with the tip of the finger, till nothing is left on the block but the strokes of ink that form the design, which mark out what part of the block is to be spared or left standing. The rest they cut off very carefully with the points of very sharp knives, chissels, or gravers, according to the bigness or delicacy of the work.

Wood *pecker*. See Picus.

WOODSTONE, in mineralogy. See Hornstone.

WOODTIN, in mineralogy. See Tin *ore*.

WOOF, among manufacturers, the threads which the weavers shoot across with an instrument called the shuttle.

WOOL, the covering of sheep. Each fleece consists of wool of several qualities and degrees of fineness, which the dealers therein take care to separate.

The fineness and plenty of our wool is owing, in a great measure, to the short sweet grass in many of our pastures and downs; though the advantage of our sheep feeding on this grass all the year, without being obliged to be shut up under cover during the winter, or to secure them from wolves at other times, contributes not a little to it.

This substance, the material of such important manufactures, possesses some curious chemical properties, none of which however are much illustrated by the various operations performed on it in manufacture, almost all (that of dying excepted) being purely mechanical processes. Some of the simple chemical properties of wool have been examined by M. Achard, and compared with the corresponding properties of the hair of different animals. The copious generation of oxalic acid by treatment of wool with nitric acid, has been particularly described and explained by M.

Berthollet in his beautiful researches on animal matter; and the great solvent power of the caustic fixed alkalies, has been happily applied to some use by M. Chaptal as a saponaceous compound.

Wool in the state in which it is taken from the sheep is always mixed with a great deal of dirt and foulness of different kinds, and in particular is strongly imbued with a natural strong smelling grease. These impurities are got rid of by washing, fulling, and combing, by which the wool is rendered remarkably white, soft, clean, light, and springy under the hand. When boiled in water for several hours in a common vessel, wool is not in any way altered in weight or texture, nor does the water acquire any sensible impregnation.

The action of the nitric acid on wool is very curious. When cold, this acid only disengages a large quantity of azotic gas, but when warmed, much nitrous gas is given out, and at least two new acids are formed, viz. the malic and the oxalic, the latter is in greater abundance than even from sugar and nitrous acid, or any other hydro-carbonous basis. A small scum of a peculiar oil always arises during the action of nitrous acid on these animal substances.

The carbonated alkalies have little action on wool, but the caustic fixed alkalies when digested with it speedily weaken its fibre, reduce it to a soft gelatinous pulp, and finally make a perfect solution. The alkali at the same time loses its alkaline properties as it does in common soap. This saponaceous solution of wool is made for experiment in a few minutes by boiling bits of wool or flannel in a caustic alkaline solution, and it has been recommended by Chaptal to be employed instead of common soap in cleansing cotton and other goods in manufactures, as by this means a number of refuse bits and clippings of wool and woollen cloth which are now thrown away may be put to some use. This soapy solution does not lather well when agitated with water, nevertheless it acts very powerfully in cleaning cloth. It has a strong and somewhat offensive smell, which is left at first in the cloth, but goes off by short exposure to the air.

Wool, either in a raw or manufactured state, has always been the principal of the staple articles of this country. The price of wool was, in very early times, much higher, in proportion to the wages of labour, the rent of land, and the price of butchers' meat, than at present. It was, before the time of Edward III., always exported raw, the art of working it into cloth and dying being so imperfectly known, that no persons above the degree of working people could go dressed in cloth of English manufacture.

The first steps taken to encourage the manufacture of woollen cloths was by Edward III., who procured some good workmen from the Netherlands, by means of protection and encouragement. The value of wool was considered as so essentially solid, that taxes were vested in that commodity, reckoning by the number of sacks; and in proportion to the price of the necessaries of life, and value of silver, wool was at least three times dearer then, than it is now. The manufacturing of cloth being once introduced into the country, the policy of preventing the exportation of the raw material was soon evident; and the first act was that of Henry IV. c. 2, by which the exportation of sheep, lambs, or rams is forbidden, under very heavy penalties.

By statute 28 George III. all former statutes respecting the exportation of wool and sheep are repealed, and numerous restrictions are consolidated in that statute. By this act, if any person shall send or receive any sheep on board any vessel, to be carried out of the kingdom, such vessel shall be forfeited, and the person so offending shall forfeit 3*l.* for every sheep, and suffer solitary imprisonment for three months. But wether sheep, by a licence from the collector of the customs, may be taken on board, for the use of the ship's company; and every person who shall export any wool, or woollen articles slightly made up, so as easily to be reduced again to wool, or any fuller's earth, or tobacco-pipe clay; and every carrier, ship owner, commander, mariner, or other person, who shall knowingly assist in exporting, or attempting to export, these articles, shall forfeit 3*s.* for every pound weight, or the sum of 50*l.* in the whole, at the election of the prosecutor, and shall also suffer solitary imprisonment for three months. But wool may be carried coastwise, upon being duly entered, and security being given, according to the directions of the statute, to the officer of the port from whence the same shall be conveyed; and the owners of sheep within five miles of the sea, and ten miles in Kent and Sussex, cannot remove the wool, without giving notice to the of-

ficer of the nearest port, as directed by the statute.

Wool *combers*. By 35 George III., c. 124, all those who have served an apprenticeship to the trade of a wool comber, or who are by law entitled to exercise the same, and also their wives and children, may set up and exercise such trade, or any other trade or business they are apt and able for, in any town or place within this kingdom, without any molestation; nor shall such wool combers, their wives or children, while they exercise such trades, be removeable from such place to their last legal settlement, till they shall actually become chargeable to such parish.

WORD, or Watch word, in an army or garrison, is some peculiar word or sentence, by which the soldiers know and distinguish one another in the night, &c. and by which spies and designing persons are discovered. It is used also to prevent surprises. The word is given out, in an army, every night to the lieutenant, or major-general of the day, who gives it to the majors of the brigades, and they to the adjutants, who give it first to the field officers, and afterwards to a serjeant of each company, who carry it to the subalterns. In garrisons, it is given, after the gate is shut, to the town major, who gives it to the adjutants, and they to the serjeants.

WORDS. As we proposed, in Philosophy, *mental*, § 104, we shall lay before our readers a view of Hartley's very important principles, respecting some of the leading phenomena of the understanding; and we beg to refer our readers to Understanding, for another branch of those phenomena. These principles illustrate and apply the doctrine of association; and we deem it certain, that the philosophy of language can be pursued with complete success, only by those who have closely attended, practically, if not theoretically, to the influence of that ever active principle.

Words may be considered in four lights: first, as impressions upon the ear; secondly, as the actions of the organs of speech; thirdly, as impressions made upon the eye by characters; fourthly, as the actions of the hand in writing. We learn the use of them in this order: for children first get an imperfect knowledge of the meaning of the words of others; then learn to speak themselves; then to read; and, lastly, to write. Now it is evident, that in the first of these ways many sensible impressions, and external feelings, are associated with particular words and phrases, so as to give these the power of raising the corresponding ideas; and that the three following ways increase and improve this power, with some additions to the ideas and variations of them. The second is the reverse of the first, the fourth of the third. The first ascertains the ideas belonging to words and phrases in a gross manner, according to their usage in common life. The second fixes this, and makes it ready and accurate. The third has the same effect as the second; and also extends the ideas and significations of words and phrases, by new associations, and in particular, by associations with other words, as in definitions, descriptions, &c. The fourth, by converting the reader into a writer, helps him to be expert in distinguishing, quick in recollecting, and faithful in retaining, these new significations of words. The action of the hand is not, indeed, an essential in this fourth method; composition by persons born blind having nearly the same effect; it is, however, a common attendant on composition, and has a considerable use deducible from association, at the same time making the analogy between the four methods more conspicuous and complete.

Hence it appears, that words and phrases must excite ideas in us by association; and it further appears, that they can do it by no other means, since all the ideas which any word excites are deducible from some of the sources above mentioned, most usually from the first or third: and because words of unknown languages, terms of art not yet explained, barbarous words, &c. have either no ideas connected with them, or only such as some fancied resemblance, or prior association suggests. It deserves to be remarked, that articulate sounds are, by their variety, number, and ready use, peculiarly fitted to signify and suggest, by association, both our simple ideas, and our complex ones formed from them.

We now proceed to describe the manner in which ideas are associated with words, beginning with childhood.

First, then, the association of the names of visible objects, with the impressions which these objects make upon the eye, seems to take place more early than any other, and to be effected in the following manner. The name of the visible object, the mother, for instance, is pronounced and repeated by the attendants to the child, more frequently when his eye is fixed upon his mother, than when upon any other ob-

jects, and much more so than when upon any particular one. The word *mamma* is also sounded in an emphatical manner, when the child's eye is directed to his mother with earnestness and desire. The association, therefore, of the sound, mamma, with the visible impression of the mother on the retina, will be far stronger than that with any other visible impression, and thus overpower all the other accidental associations; and these will also themselves contribute to the same end, by opposing one another. And when the child has acquired so much voluntary power over his motions, as to direct his head and eyes towards the nurse, upon hearing her name, this process will go on with accelerated velocity: and thus, at last, the word will excite the visible idea readily and certainly. The same association of the visible impression of the mother with the sound, mamma, will, by degrees, overpower all the accidental associations of this visible impression with other words; and, at last, be so closely confirmed, that the visible impression will excite the audible idea of the word. This, however, is not to our present purpose, but it is a process which takes place at the same time with the other, and contributes to illustrate and confirm it. Both together furnish a complete instance of one of the classes of connections. (§ 21).

Secondly, this association of words with visible appearances, being made under many particular circumstances, must affect the visible ideas with a like particularity. Thus the mother's dress, and the situation of the fire in the child's nursery, make part of the child's ideas of his mother and fire. But then, as his mother often changes her dress, and the child often sees a fire in a different place, and surrounded by different visible objects, these opposite associations must be less strong than the part which is common to them all; and consequently we may suppose, that while his idea of that part which is common, and which we may call essential, continues the same, that of the particularities, circumstances, and adjuncts, varies.

Thirdly, when the visible objects impress other vivid sensations besides those of sight, such as pleasant or unpleasant tastes, smells, warmth, or coldness, &c. with sufficient frequency, these must have relicts or ideas, (§ 7), which will be associated with the visible ideas of the objects, and with the names of the objects, so as to depend upon them. Thus, an idea of the taste of the mother's milk will rise up in the mind of the child, on his hearing her name; and hence the whole idea belonging to the word mamma now begins to be complex, consisting of two sets of ideas derived from different senses; and these ideas will be associated together, not only because the same word raises both, but also because the original sensations, were often received together. The stronger idea will therefore assist the weaker. Now, in common cases, visible ideas are the strongest; or, at least, occur the most readily; but in this case it appears to be otherwise. It would be easy to proceed to various other and more complex cases, in which the component ideas are united, and all made to depend on the respective names of visible objects; but what has been said is sufficient to show what ideas the names of visible objects, proper and appellative, raise in us.

Fourthly, we must, however, observe, respecting appellatives, that sometimes the idea is the common compound result of all the sensible impressions received from several of the objects comprised under the general appellation; sometimes, in a great measure at least, the particular idea of some one of these, namely, when the impressions arising from some one of the class are more frequent and vivid than those of the rest.

Fifthly, the names denoting sensible qualities, whether substantive or adjective, such as whiteness, white, &c. get their ideas in a manner which will be easily understood from what has been already stated. That visible impression which is common to all objects which have been frequently seen having the name, white, applied to them, becomes the leading feature of the ideas belonging to them; and the word excites that most vividly and universally, while it excites only faintly, or at least with great variation, the ideas of the peculiarities, circumstances, and adjuncts: and so of the other sensible qualities.

Sixthly, the names of visible actions, as walking, &c. raise the proper visible ideas by a like process. Other ideas may likewise adhere in certain cases, as in those of tasting, feeling, speaking, &c. Sensible impressions, in which no visible action is concerned, may also have ideas dependant upon words. However some visible ideas generally intermix themselves here. These actions and perceptions are generally denoted by verbs, though sometimes by substantives.

Seventhly, as children may learn to read words, not only in an elementary way, *viz.* by learning the letters and syllables of which they are composed, but also in a summary one, *viz.* by associating the sound of entire words with their visible representations; and must, in some cases, be taught in this latter method, that is, while the sound of the word deviates from that of its elements; so both children and adults often learn the ideas belonging to whole sentences, in a summary way, and not by adding together the ideas of the several words in the sentence. And wherever words occur, which, separately taken, have no distinct proper ideas, their use can be learned in no other way than this; and this will be the case where the words are extremely general, applying to a vast variety of visible objects, and to circumstances and relations which are not obvious to the uncultivated mind. Now, pronouns, and particles, and many other words, are of this sort. Thus, I walk, is associated at different times with the same visible impressions with, mamma walks, brother walks, &c. and therefore can for a long time suggest nothing permanently but the action of walking. However, the pronoun, *I*, in this and innumerable other short sentences, being always associated with the person speaking, (as *thou* with the person spoken to, and *he* with the person spoken of), the frequent recurrency of this teaches the child the use of the pronouns; that is, teaches him what difference he is to expect in his sensible impressions, according as this or that pronoun is used; the vast number of instances making up for the very small quantity of information which each, singly taken, conveys. In like manner different particles, (that is, adverbs, conjunctions, and prepositions), being used in sentences where the substantives, adjectives, and verbs are the same; and the same particles, when these are different, in an endless recurrency, teach children the use of the particles in a gross general way. For it may be observed, that children are much at a loss for the true use of the pronouns and particles for some years; and that they often repeat the proper name of the person instead of the pronoun; which confirms the forgoing reasoning.

Eighthly, the attempts which children make to express their own wants, perceptions, pains, &c. in words, and the corrections and suggestions of the attendants, are of the greatest use in all the steps that we have hitherto considered, and especially in the last, respecting the particles and pronouns.

Ninthly, learning to read helps children much in the same respects; especially as it teaches them to separate sentences into the several words which compose them; which those who cannot read are scarcely able to do even when they arrive at adult age.

Thus we may see how children and others are enabled to understand a continued discourse, relating to sensible impressions only; and how the words, in passing over the ear, must raise up trains of visible and other ideas, by the power of association. Our next enquiry must be concerning the words which denote either intellectual things, or collections of other words.

Tenthly, the words which relate to the several passions of love, hatred, hope, fear, anger, &c. being applied to the child when he is under the influence of these passions, get the power of raising up the ideas of those passions, and also the usual associated circumstances. The application of the same words to others helps also to annex the ideas of the associated circumstances to them, and even of the passions themselves, both from the infectiousness of our natures, and from the power of associated circumstances to raise the passions. The words, however, denoting the passions, do not, for the most part, raise up in us any degree of the passions themselves, but only the ideas of the associated circumstances. We are supposed sufficiently to understand the continued discourses into which these words enter, when we form true notions of the actions, particularly the visible ones, attending the feelings denoted.

Eleventhly, the names of intellectual and moral qualities and operations, stand for a description of these qualities and operations; and therefore, if dwelt upon, excite such ideas as these descriptions in all their particular circumstances do. But the common sentences into which these words enter, pass over the mind too quick for the most part, to allow of such delay. They are acknowledged as familiar and correct; and suggest certain associated visible ideas, and nascent internal feelings, taken from the description of these names, or from the words which are usually joined with them in discourses and writings.

Twelfthly, there are many terms of art in all the branches of learning, which are defined by other words, and which, therefore, are only compendious substitutes for

them. The same holds in common life in numberless instances. Such words sometimes suggest the words of their definitions, sometimes the ideas of these words, sometimes a particular species comprehended under the general term, &c. But whatever they suggest, it may be easily seen, that they derive the power of doing it from association.

Lastly, there are words used in abstract sciences which can scarcely be defined or described by other words, such as *identity*, *existence*, &c. The use of these must therefore be learned, as that of the particles is. Indeed children learn their first imperfect notions of all the words considered in this and the last three paragraphs, chiefly in this way; and come to more precise and explicit ones only by means of books, as they advance to adult age, or by endeavouring to use them properly in their own deliberate compositions.

From the foregoing train of reasoning the following inferences may be drawn.

1. Including under the head of definition, description, or any way of explaining a word by other words, excepting that by a mere synonymous term; and excluding from the head of ideas the visible idea of the character of a word, and the audible one of its sound, and also all ideas which are either extremely faint or extremely variable; words may be distinguished into the four following classes: 1. Such as have ideas only; 2. Such as have both ideas and definitions; 3. Such as have definitions only; 4. Such as have neither ideas nor definitions.

It is difficult to fix precise limits to these four classes, so as to determine accurately where each ends and the next begins; and if we consider these things in the most general way, there is perhaps no word which has not both an idea and a definition; that is, which is not occasionally attended with some one or more internal feelings, and which may not be explained, in some imperfect manner at least, by other words. However the following are some instances of words which have the fairest right to each class. The names of simple sensible objects are of the first class. Thus *white*, *sweet*, &c. excite ideas, but cannot be defined. Words of this class stand only for the stable parts of the respective ideas, not for the several variable particularities, circumstances, and adjuncts, which here intermix themselves.

The names of natural bodies, animal, vegetable, or mineral, are of the second class; for they excite aggregates of sensible ideas, and at the same time may be defined by an enumeration of their properties and characteristics. Thus likewise geometrical figures have both ideas and definitions. The definitions, in both cases, are so contrived as to leave out all the variable particularities of the ideas, and also to be more full and precise than the ideas generally are in the parts which are of a permanent nature.

Algebraic quantities, such as roots, powers, surds, &c. belong to the third class; and have definitions only. The same may be said of scientifical terms of art, and of most abstract general terms, moral, metaphysical, and vulgar. However, mental emotions are apt to attend some of these even in passing slightly over the ear, and these emotions may be considered as ideas belonging to the respective terms. Thus the very words, *gratitude*, *mercy*, *cruelty*, *treachery*, &c. separately taken, affect the mind; and yet, since all reasoning upon them is to be founded on their definitions, it seems best to refer them to this third class.

Lastly, the particles, *the*, *of*, *to*, *for*, *but*, &c. have neither definition nor ideas, as we have limited those terms.

2. It will easily appear from the observations here made upon words, and the associations which adhere to them, that the languages of different ages and nations must bear a great general resemblance to each other, and yet have considerable particular differences; whence any one may be translated into any other, so as to convey the same ideas in general, and yet not with perfect precision and exactness. They must resemble one another, because the phenomena of nature which they are all intended to express, and the uses and exigences of human life to which they minister, have a general resemblance. But then, as the bodily make and genius of each people, the air, soil, and climate, commerce, arts, sciences, religion, &c. make considerable differences in different ages and nations, it is natural to expect that the languages should have proportionable differences in respect of each other.

In learning a new language the words of it are at first substitutes for those of our native language; that is, they are associated, by means of these, with the proper objects and ideas. When this association is sufficiently strong, the middle bond is drop-

ped, and the words of the new language become substitutes for, and suggest directly and immediately objects and ideas; also clusters of other words in the same language.

In learning a new language it is much easier to translate from it into the native one, than back again; just as young children are much better able to understand the expressions of others, than to express their own conceptions. And the reason is the same in both cases. Young children learn at first to go from the words of others, and those who learn a new language from the words of that language, to the things signified. And the reverse of this, *viz.* to go from the things signified to the words, must be difficult for a time from the nature of successive associations. It is to be added here, that the nature and connections of the things signified, often determine the import of sentences though their grammatical analysis is not understood; and that we suppose the person who attempts to translate from a new language is sufficiently expert in passing from the things signified to the corresponding words of his own language. The power of association is every where conspicuous in these remarks.

3. It follows also from the foregoing reasoning, that persons who speak the same language cannot always mean the same things by the same words, but must sometimes mistake each others meaning. This confusion and uncertainty arises from the different associations transferred upon the same words by the difference in the accidents and events of our lives. It is, however, much more common in discourses concerning abstract matters, where the terms stand for collections of other terms, sometimes at the pleasure of the speaker or writer, than in the common and necessary affairs of life; for here frequent use, and the constancy of the phenomena of nature, intended to be expressed by words, have rendered their sense determinate and certain. However, it seems possible, and even not very difficult, for two truly candid and intelligent persons to understand each other upon any subject.

That we may enter more particularly into the causes of this confusion, and consequently be the better enabled to prevent it, let us consider words according to the four classes above mentioned.

Now, mistakes will happen in words of the first class, *viz.* such as have ideas only, where the persons have associated these words with different impressions. And the method to rectify any mistake of this kind, is for each person to show with what actual impressions he has associated the word in question. But mistakes here are not common.

In words of the second class, *viz.* such as have both ideas and definitions, it often happens that one person's knowledge is much more full than another's, and consequently his idea and definition much more extensive. This must cause a misapprehension on one side, which yet may be easily rectified by recurring to the definition. It happens also sometimes in words of this class, that a man's ideas are not always suitable to his definition; that is, are not the same with those which the words of the definition would excite. If then this person should pretend, or even design, to reason from his definition, and yet reason from his idea, misapprehension will arise in the hearer who supposes him to reason from his definition merely.

In words of the third class, which have definitions only and no immediate ideas, mistakes generally arise through want of fixed definitions being mutually acknowledged and kept to. However, as imperfect fluctuating ideas that have little relation to the definitions, are often apt to adhere to the words of this class, mistakes must arise from this cause also.

As to the words of the fourth class, or those which have neither ideas nor definitions, it is easy to ascertain their use by inserting them in sentences where import is known and acknowledged; this being the method in which children learn to decypher them; so that mistakes could not arise in the words of this class did we use moderate care and candour. And, indeed, since children learn the uses of words most evidently without having any data, any fixed point at all, it is to be hoped that philosophers and candid persons may learn at least to understand one another with facility and certainty; and get to the very bottom of the connection between words and ideas.

4. When words have acquired any considerable power of exciting pleasant or painful feelings, by being often associated with such things as do this, they may transfer a part of their pleasures and pains upon indifferent things, by being at other times often associated with such. This is one of the principal sources of the several factitious pleasures and pains of human life. Thus, to give an instance from childhood, the words

sweet, *good*, *pretty*, *fine*, &c. on the one hand; and the words *bad*, *ugly*, *frightful*, &c. on the other, being applied by the nurse and attendants in the child's hearing, almost promiscuously, and without these restrictions that are observed in correct speaking; the one set to all the pleasures, the other to all the pains of the several senses, must by association raise up general pleasant and painful feelings, in which no one part can be distinguished above the rest; and when applied by further associations to objects of a neutral kind, they must transfer a general pleasure or pain upon them.

5. Since words thus collect ideas from various quarters, unite them together, and transfer them both upon other words, and upon foreign objects, it is evident that the use of words adds much to the number and complexity of our ideas, and is the principal means by which we make mental and moral improvement. This is verified abundantly by the observations which are made upon persons born deaf, and continuing so. It is probable, however, that these persons make use of some symbols to assist the memory, and fix the imagination; and they must have a great variety of pleasures and pains transferred upon visible objects from their associations with one another, and with sensible pleasures of all kinds; but they are very deficient in this, upon the whole, through the want of the associations of visible objects and states of mind, &c. with words. Learning to read must add greatly to their mental improvement; yet still their intellectual capacities cannot but remain very narrow.

Persons blind from birth must proceed in a manner different from that before described, in the first ideas which they affix to words. As the visible ones are wanting, the others, particularly the tangible and audible ones, must compose the aggregates which are annexed to words. However as they are capable of learning and retaining as great a variety of words as others, and can associate with them pleasures and pains from the four remaining senses, they fall little or nothing short of others in intellectual accomplishments, and may arrive even at a greater degree of spirituality and abstraction in their complex ideas.

6. Hence it follows that when children, or others, first learn to read, the view of the words excites ideas, only by the mediation of their sounds, with which alone their ideas have hitherto been associated. And thus it is that children and illiterate persons best understand what they read by reading aloud. By degrees the intermediate links being left out, the written or printed characters suggest the ideas directly and instantaneously; so that persons who are much in the habit of reading, understand more readily by passing over the words with the eye only; since this method, by being more expeditious, brings the ideas closer together. However all are peculiarly affected by words pronounced in a manner suitable to their sense and design; which is still an associated influence.

WORKING, *in harvest*. A person may go abroad to work in harvest, carrying with him a certificate from the minister, and one churchwarden, or overseer, that he hath a dwelling-house or place, in which he inhabits, and hath left wife and children, or some of them, there, (or otherwise as his condition shall require) and declaring him an inhabitant there.

WORMS. See VERMES.

WORM, in gunnery, a screw of iron, to be fixed on the end of a rammer, to pull out the wad of a firelock, carabine, or pistol, being the same with the wad-hook, only the one is more proper for small arms, and the other for cannon.

WORM, in chemistry, is a long, winding, pewter pipe, placed in a tub of water, to cool and condense the vapours in the distillation of spirits.

WORM, a cable or hawser, in the sea language, is to strengthen it by winding a small line, or rope, all along between the strands.

WORSTED, a kind of woollen thread, which, in the spinning, is twisted harder than ordinary. It is chiefly used either wove or knit into stockings, caps, gloves, or the like.

WREATH, in heraldry, a roll of fine linen or silk (like that of a Turkish turban) consisting of the colours borne in the escutcheon, placed in an atchievement between the helmet and the crest, and immediately supporting the crest.

WRECK, such goods as, after a shipwreck, are cast upon the land by the sea, and left there within some county, for they are not wrecks so long as they remain at sea, being within the jurisdiction of the Admiralty.

Various statutes have been made relative to wreck, which was formerly a perquisite belonging to the King, or by special grant

to the lord of the manor. It is now, however, held, that if proof can be made of the property of any of the goods or lading which come to shore, they shall not be forfeited as wreck.

By the 3 Edward, c. 4, the sheriff of the county shall be bound to keep the goods a year and a day; that if any man can prove a property in them, either in his own right, or by right of representation, they shall be restored to him without delay.

By statute 26 George II. c. 19, plundering any vessel, either in distress or wrecked, and whether any living creature be on board or not, or preventing the escape of any person that endeavours to save his life, or putting out false lights to bring any vessel into danger, are all declared to be capital felonies; and by this statute pilfering any goods cast ashore, is declared to be petty larceny. See INSURANCE *salvage*.

WREN (SIR CHRISTOPHER), in biography, a great philosopher and mathematician, and one of the most learned and eminent architects of his age, was the son of the Rev. Christopher Wren, Dean of Windsor, and was born at Knoyle, in Wiltshire, in 1632. He studied at Wadham College, Oxford, where he took the degree of Master of Arts, in 1653, and was chosen fellow of All Souls College there. Soon after he became one of that ingenious and learned society, who then met at Oxford for the improvement of natural and experimental philosophy, and which at length produced the Royal Society.

When very young he discovered a surprising genius for the mathematics, in which science he made great advances before he was sixteen years of age. In 1657 he was made professor of astronomy in Gresham College, London; and his lectures, which were much frequented, tended greatly to the promotion of real knowledge. He proposed several methods by which to account for the shadows returning backward ten degrees on the dial of King Ahaz, by the laws of nature. One subject of his lectures was upon telescopes, to the improvement of which he had greatly contributed: another was on certain properties of the air, and the barometer. In the year 1658 he read a description of the body and different phases of the planet Saturn; which subject he proposed to investigate, while his colleague, Mr. Rooke, then professor of geometry, was carrying on his observations upon the satellites of Jupiter. The same year he communicated some demonstrations concerning cycloids to Dr. Wallis, which were afterwards published by the Doctor at the end of his treatise upon that subject. About that time also, he resolved the problem proposed by Pascal, under the feigned name of John de Montford, to all the English mathematicians; and returned another to the mathematicians in France, formerly proposed by Kepler, and then resolved likewise by himself, to which they never gave any solution. In 1660, he invented a method for the construction of solar eclipses; and in the latter part of the same year, he, with ten other gentlemen, formed themselves into a society, to meet weekly, for the improvement of natural and experimental philosophy; being the foundation of the Royal Society. In the beginning of 1661, he was chosen Savilian professor of astronomy at Oxford, in the room of Dr. Seth Ward; where he was the same year created Doctor of Laws.

Among his other accomplishments, Dr. Wren had gained so considerable a skill in architecture, that he was sent for the same year from Oxford, by order of King Charles the Second, to assist Sir John Denham, surveyor-general of the works. In 1663 he was chosen fellow of the Royal Society, being one of those who were first appointed by the council after the grant of their charter. Not long after, it being expected that the King would make the Society a visit, the Lord Brounker, then president, by a letter, requested the advice of Dr. Wren, concerning the experiments which might be most proper on that occasion: to whom the Doctor recommended principally the Torricellian experiment, and the weather needle, as being not mere amusements, but useful, and also neat in their operation.

In 1665 he travelled into France, to examine the most beautiful edifices and curious mechanical works there, when he made many useful observations. Upon his return home, he was appointed architect, and one of the commissioners for repairing St. Paul's cathedral. Within a few days after the fire of London, 1666, he drew a plan for a new city, and presented it to the King; but it was not approved by the Parliament. In this model the chief streets were to cross each other at right angles, with lesser streets between them; the churches, public buildings, &c. so disposed as not to interfere with the streets, and four piazzas placed at proper distances.

Upon the death of Sir John Denham, in 1668, he succeeded him in the office of surveyor-general of the King's works, and from this time he had the direction of a great many public edifices, by which he acquired the highest reputation. He built the magnificent theatre at Oxford, St. Paul's cathedral, the Monument, the modern part of Hampton Court, Chelsea College, one of the wings of Greenwich Hospital, the churches of St. Stephen Walbrook and St. Mary-le-Bow, with upwards of sixty other churches and public works, which that dreadful fire made necessary. In the management of which business he was assisted in the measurements, and laying out of private property, by the ingenious Dr. Robert Hook. The variety of business in which he was by this means engaged, requiring his constant attendance and concern, he resigned his Savilian professorship at Oxford in 1673, and the year following he received from the King the honour of knighthood. He was one of the commissioners who, on the motion of Sir Jonas Moore, surveyor-general of the ordnance, had been appointed to find out a proper place for erecting an observatory, and he proposed Greenwich, which was approved of; the foundation stone of which was laid the tenth of August, 1675, and the building was presently finished, under the direction of Sir Jonas, with the advice and assistance of Sir Christopher.

In 1680 he was chosen president of the Royal Society; afterwards appointed architect and commissioner of Chelsea College; and in 1684, principal officer or comptroller of the works in Windsor castle. Sir Christopher sat twice in Parliament, as a representative for two different boroughs. While he continued surveyor-general, his residence was in Scotland-yard; but after his removal from that office, in 1718, he lived in St. James's-street, Westminster. He died the twenty-fifth of February, 1723, at ninety-one years of age; and he was interred with great solemnity in St. Paul's Cathedral, in the vault under the south wing of the choir, near the east end.

WRIGHT (Edward), in biography, a noted English mathematician, who flourished in the latter part of the sixteenth century, and beginning of the seventeenth. He was contemporary with Mr. Briggs, and much concerned with him in the business of the logarithms, the short time they were published before his death. He also contributed greatly to the improvement of navigation and astronomy. He was the first undertaker of that difficult but useful work, by which a little river is brought from the town of Ware in a new canal, to supply the city of London with water; but by the manœuvres of others he was hindered from completing the work he had begun. For the improvement of the art of navigation he was appointed mathematical lecturer by the East India Company, and read lectures in the house of that worthy knight, Sir Thomas Smith, for which he had a yearly salary of fifty pounds. This office he discharged with great reputation, and much to the satisfaction of his hearers. He published in English a book on the Doctrine of the Sphere, which is very scarce and dear, and another concerning the construction of sundials. He also prefixed an ingenious preface to the learned Gilbert's book on the loadstone. He published other works, and died in the year 1615.

WRIT is the King's precept, whereby any thing is commanded touching a suit or action; as the defendant or tenant to be summoned, a distress to be taken, a disseisin to be redressed, &c. And these writs are diversely divided; some in respect of their order or manner of granting, are termed original, and some judicial. Original writs are those that are sent out for the summoning of the defendant in a personal, or the tenant in a real action, before the suit begins, or rather to begin the suit.

The judicial writs are those which are sent out by order of the court, where the cause depends, upon occasion, after the suit begins.

Original writs are issued out of the Court of Chancery, for the summoning a defendant to appear, and are granted before the suit is begun, to begin the same: and judicial writs issue out of the court where the original is returned, after the suit is begun. The originals bear date in the name of the King, but the judicial writs bear teste in the name of the chief justice.

Writ *of inquiry of damages*, a judicial writ that issues out to the sheriff, upon a judgment by default, in action of the case, covenant, trespass, trover, &c. commanding him to summon a jury to inquire what damages the plaintiff hath sustained *occasione præmissorum*; and when this is returned with the inquisition, the rule for judgment is given upon it, and if nothing be said to the contrary; judgment is thereupon entered.

A writ of inquiry of damages is a mere inquest of office, to inform the conscience of the court; who, if they please, may themselves assess the damages. And it is accordingly the practice in actions upon promissory notes and bills of exchange, instead of executing a writ of inquiry, to apply to the court for a rule to show cause why it should not be referred to the master to see what is due for principal and interest, and why final judgment should not be signed for that sum, without executing a writ of inquiry; which rule is made absolute on an affidavit of service, unless good cause be shown to the contrary.

WRITER *of the tallies*, an officer of the Exchequer, being clerk to the auditor of the receipt, who writes, upon the tallies, the whole letters of the teller's bill. See the articles TALLY, EXCHEQUER, &c.

WRITING, *origin of alphabetical.* The history of the origin and progress of written languages, is, in most of its stages, less enveloped in obscurity than that of oral language. Difficulties attend it in common with every inquiry into antiquity; but the data are more numerous and progressive than the fleeting nature of audible signs would admit. The rudiments of the art of writing are very simple; its advances towards the present state of improvement, slow and gradual. Visible language first used marks as the signs of things; and we can trace it through all its stages, from the simple picture, to the arbitrary mark for the elements of sound.

The rudest species of visible communication was, the variously-coloured knotted cords of the Peruvians, called the quipos. They have been represented by some authors as regular annals of the empire; but though they might have some significancy by agreement, it is probable that without oral interpretation they would denote nothing more than that something was to be remembered, like the twelve stones in Joshua, iv. 21, 22. Robertson, with more probability, supposes that they were a device for rendering calculation more expeditious and accurate; that by the various colours, different objects were denoted; and by each knot, a distinct number. This is rendered still more probable by the circumstance, that picture-writing was used by the Peruvians; and, as the names of numbers must be denoted by arbitrary signs to render calculation at all extensive, this species of arbitrary sign might be more convenient for their rude arithmetic than any other.

Picture-writing, such as was adopted by the Mexicans, is the first step of the progress towards letter-writing. The simplest species was a mere delineation of the object to be denoted. Thus the North-American Indians, when they went to war, painted some trees with the figures of warriors, often of the exact number of the party; and if they went by water, they delineated a canoe. Thus, too, the Mexicans, at the arrival of the Spaniards, sent large paintings on cloth as dispatches to Montezuma. The Mexicans had made some progress beyond simple delineations; but of these their paintings are principally composed, and by a proper disposition of their figures, they could exhibit a more complex series of events in historical order. Some very curious specimens of this picture-writing are preserved: the most valuable one has been published, and may be found in Purchas's "Pilgrim," or in Thevenot's "Collection of Voyages." It is divided into three parts: the first is a history of the Mexican Empire; the second is a tribute-roll; and the third, a code of their institutions.

The defects of this mode of communication must have been early felt. Where applicable, it was tedious; and was confined to objects of sense. The human intellect, stimulated by the necessity of improvement, would have proceeded through the same course in the New World as in the Old; but a stop was put to this progress by the destruction of the most cultivated empires. Picture-writing, then the simple hieroglyphic, then the symbolical hieroglyphic, then the arbitrary character for words, and, lastly, for letters, was the evident progress of the mind. The Mexicans had actually, in some instances, passed through all the intermediate stages; though the short duration of their empire prevented them from extending these rudiments to a regular system. In the simple hieroglyphic, the principal part or circumstance of a subject is placed for the whole. In the historical painting before mentioned, towns are uniformly denoted by the rude delineation of a house, to which was added some distinguishing emblem: these emblems were denotements of their names, which were generally significant compounds. Kings and generals were in like manner denoted by heads of men, with similar emblematic

marks conjoined. They also used the symbolical hieroglyphic to denote a conqueror: they placed a target, with darts between the characters, for the king, and the cities which he had subdued. Their marks for months and other portions of time, for the air, the earth, &c. were symbolical; and their cyphers are arbitrary characters: they painted as many small circles as there were units to 20, which had its proper mark; by the successive addition of these marks they denoted numbers to 20 times 20, or 400, which again had its proper mark; then, by the successive addition of these, they denoted as far as 20 times 400, or 8000, which had a new character. Whatever their advances, however, annals so conveyed must have been very imperfect; and accordingly they took great pains to instruct the young to supply the deficiencies, and to remove the ambiguities, by means of traditionary explanations. See Robertson's "America," vol. iii. p. 173—180; from whom, and Clavigero, this account is derived.

Picture-writing and its contraction, which is denominated the simple hieroglyphic, must be very inadequate for the purposes of communication. The figurative hieroglyphic would soon be adopted; for oral language must have made some progress, before the use of permanent visible communication would be found necessary, and, consequently, must have given metaphorical meanings to the names of sensible objects. We here speak of hieroglyphics as intended for the purposes of *communicating*, not of *concealing* knowledge. It was long thought that the latter was the first and only purpose. Warburton has proved that this was not their first use, but that which was made of them in a later period, particularly when the invention of letters had rendered the former purpose unnecessary. The simple hieroglyphic was, where the delineation of part of the object or action represented the whole. Thus the ancient Egyptians painted a man's two feet in water to denote a fuller; smoke ascending, to denote fire; two hands, one holding a buckler, the other a bow, to denote a battle.—The figurative hieroglyphic was of two kinds: one, where the instrument, real or supposed, was used to denote the performer, or the thing performed; the other, where one object was used to represent another, which had some real or supposed resemblance to it. Egyptian examples of the first kind are, an eye and a sceptre, to signify a king; a sword, a bloody tyrant; the mouth, to denote speech or voice; the sun and moon, as a symbol for succession of time; an eye placed in an eminent position, for the omniscience of God. Examples of the second are, a dog's head (as among the Chinese, a dog's voice), to denote sorrow; dew falling from heaven, to denote science. To these may be added, as a mixed example, the inscription on the temple of Minerva at Sais: where are found, engraved on the vestibule, the figures of an infant, an old man, a hawk and a fish, and a river horse: the hawk and fish were the symbol for hatred, and the river horse for impudence; so that the literal translation would be "young and old hate impudence," or, still more literally, "old man, infant hatred, impudence." The Scythian King sent to Darius a mouse, a frog, a bird, a dart, and a plough: if he had sent their delineations, it would have formed a similar specimen of the hieroglifhic.

Hieroglyphics would frequently be founded on the figures to which use had given currency in oral language. The procedure of the mind is the same in both; and they would mutually influence each other. With respect to the simple hieroglyphic, as that was a mere contraction of the full delineation in picture-writing, the only similarity we must expect to find in language is the contraction of words. Both were intended for the purpose of facilitating communication, by increasing its rapidity.

The first use of hieroglyphics was, to preserve the memory of events and institutions; such symbols, therefore, would first be adopted as were of obvious interpretation; *viz.* those which were founded on prevailing opinions; as, the hyena, for a man bearing his distresses with fortitude, and rising superior to them, because the skin of that animal was supposed to render the wearer dauntless and invulnerable; on those founded on oral language, which would be intelligible when the analogies which gave rise to them were forgotten. By degrees they were employed for the more refined purposes of philosophy; and the analogies on which they were founded, would require an acquaintance with the sciences from which they were deduced. Still nothing was done for concealment: at last superstition appropriated their use; and after the invention of letters, they were employed to keep the mysteries of the priesthood from the eyes of the profane vulgar. Their symbols were now formed of far-fetched resemblances: a cat was used

to denote the moon, from the supposed contraction or dilatation of the pupil of her eye, at different parts of the lunation. In common hieroglyphics, Egypt was denoted by a crocodile; in the sacred, by a heart on a burning censor. One animal, or other sensible object, was used to denote a variety of qualities; and the same idea was denoted by various hieroglyphics. This has attached to the whole hieroglyphical system the character of mystery: when we trace the progress of the Chinese language, we shall have additional proofs of the injustice of this opinion.

The exact manner of delineation would be tedious and voluminous. The more use was made of visible communication, the more we may expect to find the character, originally significant, become a mere arbitrary mark. In the early stages of the Egyptian hieroglyphics, considerable attention was paid to the outline and filling-up of their figures. Afterwards a rude outline was sufficient; and this was changed, for the convenience of the writer, till it lost every resemblance to the object it originally represented. Many changes in our own written character might be adduced, illustrative of this change from the delineation to the cursive hieroglyphic. The mark for *and*, for instance, was once the correct picture of *et*: some forms show its origin, as &; at present, in writing at least, it bears no features of resemblance to its original. The use of the cursive hieroglyphic would take off the attention from the symbol, and fix it upon the thing signified; a progress which we equally observe in oral language, where words, originally denotements of sensible objects, became the names for mental qualities bearing some resemblance to what they before signified, and in many instances have been appropriated to the mental quality without any reference to the original meaning.

Visible characters having become arbitrary marks for ideas or words, two processes were pursued by different districts of Asia and Africa: the one was to consider these characters as signs for sounds, and, by their intervention, of ideas; the other, as signs for ideas without any reference to sounds. The latter was the procedure of the Chinese; the former, of all nations who used alphabetical characters.

On the Chinese Language.

We come now to the consideration of a language singular in all its parts, and possessed of such peculiar features that it well deserves our attention. The written language of the Chinese has passed through all the gradations which we have described; and from their pictures, characters have become mere arbitrary marks: these are employed, not as signs for sounds, but for ideas; and their combinations and changes have no corresponding combinations and changes in the spoken language of China. Before the time of their first emperor, Fohi, the Chinese are supposed to have employed knotted cords, like the Peruvians. Fohi introduced in their place horizontal lines (see Plate Miscel. fig. 14); some whole, others divided; and by their combination in threes, formed the text of the most ancient Chinese work, called "Ye King." On these trigrams numerous commentaries have been written, some as early as 1100 years before Christ: they are supposed to contain, in a few lines, the most sublime truths, and are employed in divination; but they are still unintelligible. By Xin-nung, the successor of Fohi, sixty-four hexagrams (like those in fig. 15), were invented, which are supposed to contain the whole circle of human knowledge. It is thought that these characters were taken from the knotted cords, and it seems to us probable that they expressed no more. The time of their invention (which is carried back to the age of Noah), and their apparent inadequacy to represent more than numbers, render it highly improbable that they were intended to denote the mysteries of philosophy. The present numerals of the Chinese have an equal right to be esteemed the mysterious denotements of science. Whatever be the justness of this idea, it is certain that these trigrams and hexagrams are not the origin of the present Chinese character. In numerous instances, the progress can be traced from pictures or symbols to the present form; in some the connecting steps are lost, but the general inference is still a just one. The present form seldom presents any traces of its original. Tien (fig. 16), heaven, has no longer a natural or symbolical resemblance to the object; but it was first represented by three curved lines (as in fig. 17), and, through the various changes in fig. 18, it has arrived at its present form. Several other examples are given in the Phil. Trans. vol. lix.

Before we advance further respecting the written language of the Chinese, it will be proper to attend a little to their oral language. This, as was observed in LANGUAGE,

is entirely monosyllabic; and all the words may be expressed by an European consonant and a vowel, with the exception of about one-third, which end with n either simple or nasal. A monosyllabic language cannot be copious; and we expect to find it less so when the number of simple sounds are small. The Chinese have not the *b*, *d*, and *r*, of the Europeans; and the number of their words is only 330. The capabilities of their oral language are, however, much extended by the variation their words undergo, by means of tone and other inflexions of the voice. These changes require a very discriminating ear to perceive, and very flexible organs to express them; but we know the power of habit, and can readily admit that thus the meaning of their words may be extended, without confusion, even to things very opposite in their nature. When, however, we find (as Hager informs us), that the same word often answers to six hundred different significations, according to the tone with which it is pronounced, the place which it occupies, or the character by which it is expressed, we must suppose it impossible to avoid frequent ambiguity.

Notwithstanding, however, all their changes in tone, &c. they have not more than 1,500 distinct sounds. Most nations have improved their oral languages; the Chinese have directed all their attention to the improvement of their written language, and they have formed combinations in their characters without any corresponding combinations in their sounds. Their changes are totally independent of each other; and the former are understood where the sounds corresponding to them are different from those of the Chinese. In this respect they may be compared to the arithmetical cyphers, &c. The character for *tsai*, calamity, is an example of this independent combination. It is composed of *mien*, a house, and *ho*, fire. Our process is to join the oral words expressing the ideas we wish to combine; and we should use *mienho*. We cannot easily and fully enter into this independency of character or sound, because all our words are more or less pictures of sound, and are so strongly associated with sound that it is difficult to separate them completely, even in imagination. The Chinese on the other hand have no immediate connection between their words and their characters, so that it cannot be necessary in using their characters to use the sounds at all.

All the Chinese characters are composed of 214 clefs or keys. These represent the most obvious and simple ideas; and by their combinations are produced expressions for the more refined and complex ideas. All these clefs were probably simple paintings or symbols, and hence the whole written language may be fairly considered as deducible from the more obvious writing of the Mexicans and Egyptians. Indeed the resemblance between the ancient Chinese characters and the Egyptian hieroglyphics is so striking, and this in cases where the analogy on which both were founded, is not an obvious one that De Guignes considers them as certainly derived from the same source. These keys are at present formed from six simple strokes; a horizontal line, two perpendicular (the one pointed, the other blunt at bottom) a point, a line curved to the right, and another to the left. The greater part of the keys have from two to seven strokes; six only of one, and some have sixteen or seventeen. We are not however to suppose that the inventors of the Chinese characters fixed upon these six elements and composed from them methodically. As the characters lost their correctness of delineation, the object was to facilitate the labour of writing. Art by degrees reduced all the characters to the simple strokes we have mentioned.

These keys are either employed alone as a character serving to express an idea; or differently combined in a group, forming a phrase expressive of the idea it is intended to communicate. Thus the character for night is composed of three characters; one signifying darkness, another the action of covering, the third signifying man, which, rendered literally, signifies darkness covering man; a phrase perfectly expressive, and similar to the language of poetry. Both in fact issued "from the cradle of the human race." Figurative language of this kind is much employed in the scriptures: we admire it; for it "comes home to our business and our bosoms." It paints to our minds, and calls up their conceptions forcibly and correctly. Hence, though the offspring of necessity, it is justly esteemed a beauty; and wherever the language of feeling is employed will generally be found a prevailing trait.

We might suppose that all the characters being thus composed nothing more would be necessary, in order to understand them, than to know the elementary characters; but the analogy on which the composition

is formed is often extremely obscure, and often erroneous. Their ancient principles of philosophy furnished wide scope for combination; but these were generally ill founded. Other combinations acquire a knowledge of their ancient customs and popular superstitions. Hence the ease which we should in theory expect in understanding a language so regularly formed vanishes; and an acquaintance with their whole round of physical and religious dogmata, with the fleeting customs and opinions of preceding ages, is necessary for a thorough acquaintance with the Chinese characters. This is not, however, entirely peculiar to the Chinese language. In order to trace the origin of words, the same references are often necessary; but we have more frequently the requisite data. *Candidate* signifies a person who offers himself to fill a lucrative or honourable situation; the original meaning of the Latin *candidatus* is a person dressed in white. The two ideas seem to have no connection. The difficulty vanishes, however, when we learn that among the Romans all candidates wore white robes. In a similar manner we see no connection between running, and wrapping up the feet; but *pao*, the Chinese character for *run*, is composed of two, one for the act of wrapping, the other for feet. The probable connection is ascertained by the circumstance that the savages of Louisiana, when about to undertake long marches wrap up their feet to prevent their being torn.

In the Chinese dictionaries the keys are placed in an invariable order which soon becomes familiar to the student. The different compounds each follow one another according to the number of strokes of which each consists. The meaning and pronunciation are given by means of two words in common use. When no one common word expresses the exact sound it is communicated by two connected, with marks to show that the consonant of the first word and the vowel of the second joined together form the precise sound wanting. Thus, to express the sound *pien*, *pa* and *mien*, would be joined with marks to denote the elision of the *a* and the *m*.

If the spoken language be scanty, this is not the defect of the written language. Their characters amount to 80,000. A considerable part of them however may be considered as synonima; thus age may be expressed by a hundred different characters, and happiness may be traced into as many forms in expressing the general wish for it. Different sects have their own characters; so that when a proper allowance is made, about 10,000 are sufficient for reading the best books of each literary period of their language. In alphabetical writing words may be read without the least knowledge of their meaning; in the hieroglyphical the sound is less intimately connected with the visible sign, and the character is studied and best learned by becoming acquainted with the ideas attached to it. But the terms of philosophy have been formed on that philosophy, so that a knowledge of the latter is necessary to a complete acquaintance with the former. These ideas we must call to mind when we hear that their most learned men are not acquainted with more than half of them. The knowledge of the whole round of Chinese science and literature must surely be sufficient to occupy the life of the longest liver.

Transition to Letters.

Upon the principle that we ought not to suppose divine interposition merely from the difficulty of accounting for a phenomenon, we should argue *à priori* that no divine interposition took place in the origin of alphabetical writing. As however some presumptive arguments in favour of the affirmative side of the question have been advanced by men of the first eminence; we shall state the most important of them, and after endeavouring to lessen the difficulty they may present to our admission of the human origin of letters. We shall point out what appears to be the most probable account of their invention.

1. It is urged that in order to give any plausibility to the hypothesis of the human invention of letters, it must be shown to be simple. Now if it were simple and obvious, it is highly probable that we should find instances of independent invention. But the fact is, that alphabetical writing may be traced to one source.

Two answers may be given to this argument. First. There is such a great dissimilarity among the Asiatic alphabets, that they cannot be proved to have issued from the same source. It must however be remarked, that the variations which we know to have taken place in numerous instances would destroy the force of any objection that might occur from this decided dissimilarity, if positive arguments were adduced

to establish their identity of origin. But though these are apparently sufficient to render it probable, yet this probability is not great enough to give much weight to the argument in question. But even admitting its certainty, we may observe, secondly, that this can prove no more than the high antiquity of the invention. That it originated before mankind were much separated from each other; and that the ground-work, laid by those who had made the greatest advances in cultivation, was built upon in different ways by those who afterwards penetrated to the remoter parts of the Continent. But it is urged,

2. That we not only have no instance of independent discovery, but have even the example of a nation which had no communication with those among whom it was first known, remaining in total ignorance of it, and employing a procedure which now incapacitates them for the adoption of alphabetical writing. And the force of this objection is materially increased by the circumstance that their writing equally with the alphabetical, originated in the hieroglyphics, and actually went through the same stages, *viz.* from the simple picture to the arbitrary mark. The grand weight of the controversy appears to rest here. The difficulty this argument presents may probably be obviated by the following considerations:

First, The written language of China was cultivated more for the purposes of literature and philosophy than for those of common life; the combinations were formed by the literati, and it probably would not have been in their power to have carried these combinations into the oral language of the vulgar. They might indeed have invented an oral language corresponding to their characters; but the genius of the Chinese seems rather to direct them to study than to conversation. In order to render probable a transition from hieroglyphics to letters, we must suppose the spoken and the written language to have been connected with each other, and to have had similar combinations. Now we may observe,

Secondly, That the spoken language of China did not at all favour the plan of making their characters representative of sound, for being all monosyllables, and not very numerous, there would not be the same call for attention to the elementary sounds; and what would still more prevent this direction of the attention, they did not vary the articulation but the tone, in order to express a variation of meaning. Add to this,

Thirdly, The great extent of the empire of China and its dependencies, would cause a great variety in the dialect. This would contribute to increase the attention of their literati to their written language, since this (as we have seen it actually is) might be understood independently of their words.

Fourthly, If we admit the very probable hypothesis of De Guignes, that the Chinese characters were brought from Egypt, and that they had originally no connection with the spoken language of the country into which they were imported;—that, in fact, they were applied to denote names different from those with which they had been before connected;—we shall perceive at once the reason why the combinations of the characters were originally unaccompanied with corresponding combinations of sounds. After this there is no difficulty in admitting that the written must continue independent of the spoken language, especially among people so little addicted to innovation as the Chinese.

3. It is urged that the invention of letters is ascribed to the gods by several of the ancients; that Pliny asserts the use of letters to have been eternal; and that the Jewish doctors maintain that God created alphabetical writing.

We say, in reply, that the Jews had no other records than our own. The ancients were accustomed to ascribe to a divine origin every thing for which they could not account. As for Pliny he expressly says that the Phenicians were famed as the inventors of letters.

It must be remarked that these facts are adduced to prove that no records of the invention remain; indirectly therefore they favour the hypothesis of the divine origin of letters. If, however, the transition were simple and gradual, perhaps the era of invention could not have been fixed even by the nation in which it occurred. We have no more reason to expect records of the invention of letters than of the Egyptian hieroglyphics, or of the Chinese characters.

The arguments *à priori* for the divine origin of letters, remain to be considered. These are, the difficulty of the invention in any stage of human progress, and its antiquity, which very much increases the improbability of its human origin.

1. As to the difficulty of the invention,

it is urged that we are to suppose that the inventors of letters decomposed the sounds of words not only into syllables, but into letters; that observing the component parts of syllables, and denoting them by appropriate marks, they used these marks for those elementary sounds in the visible representation of other words into which those sounds entered. This dissection of the articulate sounds of man, tracing them through all their various combinations, and denoting them by a few simple marks, whose combinations might express every possible combination of sound, supposes a habit of patient experimenting, of discriminating examination, and of exact classification, which ill accord with the uncultivated state of human intellect in the early period of society. But,

2. When we consider the antiquity of the use of letters, and find them in a state of perfection so early as the time of Moses, this difficulty appears insuperable. We must admit that men in the earliest ages stepped at once from a tedious and awkward, and frequently unintelligible mode of communication to one which answers every purpose in the shortest way, and that unlike all other inventions it was brought at once to such a state of perfection that no succeeding alphabet has any real superiority over the ancient Hebrew.

With respect to the difficulty of the invention, the objection loses all its force when a simple and easy procedure, probable in the given circumstances, can be pointed out. To obviate the difficulty arising from the apparent perfection of the most ancient alphabets, we may observe,

First, That in a perfect alphabet every letter should represent only one definite sound, and every known sound in the given language should have a corresponding letter. Now we have no instance of a perfect alphabet among modern languages, and have therefore no reason to suppose that the first alphabet was perfect. But even admitting that some of the ancient alphabets which have been transmitted to us were perfect, yet it must be observed,

Secondly, That no known alphabet, however ancient, is in the state of its original invention. Cadmus, who was born in the east, carried with him into Greece sixteen letters only; the least copious alphabet we are acquainted with has twenty-two. It is not probable that Cadmus introduced fewer than he possessed; it is more probable that he invented new ones to express sounds which he found among the aborigines.

It has generally been supposed of late, that alphabetical writing was formed from hieroglyphics; but we have met with no one, except De Guignes, who has stated the steps of the transition in a satisfactory manner. "Perhaps," says this writer, "we have done too much honour to the inventor of letters, whoever he were, in supposing that he dissected the voice into two parts, and invented marks of two kinds, some to represent consonants, and others vowels."

The following is, with some variations, the hypothesis of this writer. Hieroglyphics, with their exactness of delineation, lost their original significancy. This must first be the case with words of most frequent recurrence, and which entered most into combinations with other words; become simple denotements of sound they were employed to express their respective sounds in combinations of other monosyllabic words, which, in like manner had lost their original significancy. Hence, by degrees, they became representative of the component parts of all words into which their respective sounds entered. They were always words, but very simple, consisting only of a consonant and a vowel. Variation in the pronunciation of the vowel would occur in different dialects, and hence these marks would be regarded as consonants capable of being differently modified by simple vocal sounds. Letters, at first monosyllabic words, then became marks for the component parts of dissyllabic or polysyllabic words; and then for the unchangeable part of those syllables, that is, for consonants. In the most ancient state of the oriental languages vowel sounds had no distinct marks. In the latter marks were joined to the consonant to express the different sounds with which the radical consonant was invested. Among the western nations a different procedure was adopted. In some cases they used the mark which they had received from the oriental nations for an aspirate and vowel, for the vowel itself; and having once commenced the use of distinct marks for vowels, the procedure was continued, and new marks adopted to express noticed variations of vocal sounds.

In support of this statement may be adduced the following observations:

1. We have seen that hieroglyphics did become significant of sounds; and (see LAN-

GUAGE) that words, originally significant of one class of ideas, being applied to a second, lost their connection with the former, and became directly significant of the latter.

2. We have reason to believe that words were originally monosyllabic in those nations where alphabetical writing was invented, and that the combination of old sounds, or the use of them, uncompounded to express new ideas, was the mode employed to extend the capabilities of their language. Hence the same word would frequently occur in combination, and though its different significations must originally have been represented by different hieroglyphics, yet as these lost their significancy, they would easily become as extensive in their meaning as the sounds themselves. And it is obvious that the most simple of those hieroglyphics which were used for the same sound, would be employed to represent the sound.

3. It has been shown to be highly probable that originally every consonant had its vowel sound. Hence all syllables might be represented by two, or at most three European letters. This circumstance would materially diminish the varieties of syllabic sounds.

4. The probability of the theory advanced depends greatly upon the hypothesis, that originally letters were syllabic. The following facts appear to prove this: The ancient oriental alphabets had no denotements for vowels, and even if this be disputed, it must be admitted that they had many words into which none of the supposed vowel marks entered. The Ethiopian alphabet is intirely syllabic. The simple letters denote a consonant and a short *a*, and marks were added to them to denote other vowels where used. What is doubly singular, they have in many cases added marks to these syllabic characters, to denote they have no vowel belonging to them. In the Coptic and Arabic there are syllabic characters. The alphabets of the eastern Asiatics are principally syllabic, some with ŏ, others with ă, joined to a consonant. These circumstances render probable the account here given of the transition from hieroglyphics to letters. The following observations more completely ascertain its high probability.

5. The letters of some of the ancient alphabets have so great a resemblance to the hieroglyphical characters; indeed are such exact transcripts of them, that a simple inspection is sufficient to convince us that hieroglyphics were the origin of letters. This, however, proves little as to the invention of alphabetical writing, except that it was subsequent to the use of hieroglyphics. But,

6. These characters, in many instances, retained their original significancy, which proves them to have been, as De Guignes supposes, denotements for words. We must not expect to find this significancy in all words of which they form component parts; but in such only in whose visible representation the original hieroglyphic formed a component part. Now we must observe first, that the names of several of the oriental letters are still by themselves significant, and that some of these letters are similar to the Chinese clefs, which have the same signification. Thus the י *yod* signifies the *hand*. Its form, in some alphabets, resembles the Chinese character for *hand*. The ד *daleth* of the Hebrews, Phenicians, and Ethiopians, signifies *a gate*, and the action of opening. The hieroglyphic which among the ancient Chinese represented *a gate*, is exactly similar to this letter. The פ *phi* of the Hebrews and *af* of the Ethiopians signifies the *mouth*. The Chinese characters for the *mouth* all resemble it. The ע *ain* signifies the *eye*. The Phenicians and the Chinese employed the outline of the eye as a denotement of the object. The ש *shin* in Hebrew signifies the *teeth*, and its figure is still found among the Chinese with the same signification. The ם *mim* signifies *water*. The corresponding Samaritan and Ethiopian characters have a strong resemblance to the Chinese hieroglyphic for water. Lastly, the א *aleph* (originally perhaps signifying *ox*) signifies *unity*, the *action of conducting*, *pre-eminence*. The Phenician form of this exactly represents the Chinese character for *one*, and *every action by which we are at the head of others*. But these letters are not only significant by themselves, but secondly in combinations. Thus י was expressed by the monosyllable *ya*, *ye*, or *you*; to this another monosyllable, which had equally a signification relative to the figure being added, formed a word of two syllables. For instance, instead of the present denomination of ד *daleth*, we may reasonably suppose its original sound to have been *da*. The word די *yada*, hieroglyphically represented by *a gate* and *a hand*, is found in the Hebrew with a signification derived from that of the letters composing it; to *cast*

out (as we might say, *hand* him to the *door*), to *extend*. Add to this the word ע *ain* (originally probably sounded *ho*), which signifies the *eye*, and we have *yadaho*, which should signify to *open the eyes*, to *extend the view*, &c. and metaphorically, to *know*, to *understand*; and, in fact, this is the signification of ידע in Hebrew. But this is not all, for exactly the same procedure has been adopted by the Chinese. *Ki*, which signifies to *examine*, is composed of three radical characters, of which the first signifies *the hand*, the second *a gate*, the third *the eye*. So also *kia* is composed of three characters, one signifying the *teeth*, the other two, *gate* or *opening*, which signifies to *break through*, to *make a great opening*. In Hebrew שוד is similarly composed. It signifies to *plunder*, to *lay waste*. *Tchi* is a large collection of water. It was composed of the characters for *hand* and *water*. The same compound was formed among the Hebrews, and ים *yam* signifies a *great collection of water*, or *the sea*. In Arabic the letters *thet* or *earth*, and *mim* or *water*, from the word *tham*, and signify a *flood*. The Hebrew *thin* is composed of the *thet* or *earth*, and the *nun*, which signifies *man*, *i. e. man of the earth*, and further, to *form*. to *create*. In both these instances the Chinese correspond in their combinations with the alphabetical writing. Many other instances might be brought. We will adduce one to which there is no corresponding combination in the Chinese language. *Ab* or *Huba*, אב, signifies father. The component parts of it signify *principal of the house*.

The papers of De Guignes, to which we are very greatly indebted on this subject, are to be found in Memoires de l'Academie des Inscriptions ét des Belles Lettres, vol. 34, &c.

WRONG *stamp*, By 37 George III. c. 136. any instrument (except bills of exchange, promissory notes, or other notes, drafts, or orders) liable to stamp-duty, whereon shall be impressed any stamp of a different denomination, but of an equal or greater value than the stamp required, may be stamped with the proper stamp after the execution, on payment of duty and five pounds penalty, but without any allowance for the wrong stamp.

Likewise any such instrument (except as aforesaid) being ingrossed without having been first stamped, or having a stamp thereon of less value than required, the same may be stamped after the execution, on payment of the duty and ten pounds penalty only, for each skin thereof: but in case it shall be satisfactorily proved to the Commissioners of Stamps, that the same hath been so ingrossed either by accident or inadvertency, or from urgent necessity, or unavoidable circumstances, and without any intention of fraud, the Commissioners are authorized to stamp the same within sixty days after the execution, to remit the penalty in part, or in all, and to indemnify persons so ingrossing the same.

WULFENIA, in botany, so named from the Rev. Francis Xavier Wulfen, a genus of the Diandria Monogynia class and order. Essential character: corolla tubular, ringent, with the upper lip short, entire, the lower three-parted, with the aperture bearded; calyx five-parted; capsule two-celled, four-valved. There is only one species, *viz.* W. carinthiaca, a native of Carinthia, on the highest Alps.

WURMBEA, in botany, so named in honour of Frederick Baron Van Wurmb, a genus of the Hexandria Trigynia class and order. Natural order of Coronariæ. Junci, Jussieu. Essential character: calyx none; corolla six-parted, with a hexangular tube; filaments inserted into the throat. There are three species.

WYTE, or WITE, in our ancient customs, a pecuniary penalty or mulct. The Saxons had two kinds of punishments, *were* and *wyte*; the first for the more grievous offences. The wyte was for the less heinous ones. It was not fixed to any certain sum, but left at liberty to be varied according to the nature of the case. Hence also wyte, or wittree, one of the terms of privilege granted to our sportsmen, signifying a freedom or immunity from fines or amerciaments.

X.

X, or *x*, is the twenty-second letter of our alphabet, and a double consonant. It was not used by the Hebrews or ancient Greeks; for as it is a compound letter, the ancients, who used great simplicity in their writings, made use of, and expressed this letter by its component letters *cs*. Neither have the Italians this letter, but express it by *ss*. X begins no word in our language but such as are of Greek original, and is in few others but what are of Latin derivation, as *perplex*, *reflexion*, *defluxion*, &c. We often express this sound by single letters, as *cks* in *backs*, *necks*; by *ks* in *books*, *breaks*; by *cc* in *access*, *accident*; by *ct* in *action*, *unction*, &c. In numerals it expresseth 10, whence in old Roman manuscripts it is used for *denarius*; and as such seems to be made of two V's placed one over the other. When a dash is added over it, thus $\overline{X}$, it signifies ten thousand.

XANTHE, in botany, a genus of the Dioecia Syngenesia class and order. Essential character: flowers dioecious; calyx five, six-parted, permanent; corolla five, six-petalled: males with one filament, bearing five anthers, collected into a shield-shaped head: females with five barren anthers; capsule globose, crowned with the stigma, five-striated, five-valved; seeds very many, involved in the pulp. There are two species, *viz.* X. quapoya, and X. panari.

XANTHIUM, in botany, a genus of the Monoecia Pentandria class and order. Natural order of Compositæ Nucamentaceæ. Corymbiferæ, Jussieu. Essential character: male, calyx common, imbricate; corolla one-petalled, five-cleft, funnel-form; receptacle chaffy: female, calyx involucre, two-leaved, two-flowered; corolla none; drupe dry, muricated, two-cleft; nucleus two-celled. There are five species.

XANTHORHIZA, in botany, a genus of the Pentandria Polygynia class and order. Natural order of Ranunculaceæ, Jussieu. Essential character: calyx none; petals five; nectary five, pedicelled; capsule five, one-seeded. There is only one species, *viz.* X. apiifolia, a native of North America.

XANTHOXYLUM, in botany, a genus of the Dioecia Pentandria class and order. Natural order of Hederaceæ. Terebintaceæ, Jussieu. Essential character: calyx five-parted; corolla none: female, pistil five; capsule five, one-seeded. There is but one species, *viz.* X. clava herculis, tooth-ache tree, it grows naturally in Pennsylvania and Maryland.

XERANTHEMUM, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx imbricate, rayed, with the ray coloured; down bristle-shaped; receptacle chaffy. There are twenty-seven species.

XIMENIA, in botany, so named in honour of the Rev. Father Francis Ximenes, a Spaniard, a genus of the Octandria Monogynia class and order. Natural order of Aurantia, Jussieu. Essential character: calyx four-cleft; petals four, hairy, rolled back; drupe one-seeded. There are three species.

XIPHIAS, the *sword-fish*, in natural history, a genus of fishes of the order Apodes. Generic character: head with the upper jaw ending in a sword-shaped snout; mouth without teeth; gill-membrane eight-rayed; body roundish, without scales. There are three species; X. gladeus, or the common sword-fish, is of the length of twenty feet, and is particularly distinguished by its upper jaw being stretched to a considerable distance beyond the lower, flat above and beneath, but edges at the sides, and of a bony substance, covered by a strong epidermis. It is a fish extremely rapacious, and finds in the above instrument a weapon of attack and destruction, able to procure it the most ample supplies. It first transfixes its prey with this snout, and then devours it. It is found in the Mediterranean, chiefly about Sicily, and is used as food by the Sicilians, who preserve it for a long time by salting it in small pieces. See Pisces, Plate VI. fig. 5.

X. platypterus, or the broad-finned sword-fish, is found in the Northern, Atlantic, and Indian Seas, and is considered as one of the

most fatal enemies of the whale tribe. Its strength is so great that it is said to have pervaded with its snout, or sword, the plank of an East Indiaman; and a plank and snout in attestation of this circumstance, the latter closely driven into the former, are to be seen in the British Museum, having been communicated to Sir Joseph Banks by an East India Captain, of honour and veracity. When young this fish is used for food, but after it exceeds four or five feet in length.

XIPHIDIUM, in botany, a genus of the Triandria Monogynia class and order. Natural order of Ensatæ. Irides, Jussieu. Essential character: corolla six-petalled, equal; capsule superior, three-celled, many-seeded. There are two species, *viz.* X. album and X. cæruleum.

XYLOCARPUS, in botany, a genus of the Octandria Monogynia class and order. Essential character: calyx four-toothed; corolla four-petalled; nectary eight-cleft; filaments inserted into the nectary; drupe juiceless, large, four or five-grooved; nuts eight or ten, difform. There is but one species, *viz.* X. granatum, a native of the East Indies.

XYLOMELUM, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Proteæ, Jussieu. Essential character: ament with a simple scale; petals four, staminiferous; stigma club-shaped, obtuse. This is one of twenty new genera from the South Seas; the characters of which are given by Dr. Smith.

XYLON. See GOSSYPIUM.

XYLOPHYLLA, in botany, *sea-side laurel*, a genus of the Pentandria Trigynia class and order. Natural order of Tricoccæ. Euphorbiæ, Jussieu. Essential character: calyx five-parted, coloured; corolla none; stigmas jagged; capsule three-celled; seeds two. There are seven species.

XYLOPIA, in botany, *bitter-wood*, a genus of the Polyandria Polygynia class and order. Natural order of Coadunatæ. Anonæ, Jussieu. Essential character: calyx three-leaved; petals six; capsule one or two-seeded, four-cornered, two-valved; seeds arilled. There are three species.

XYLOSMA, in botany, a genus of the Dioecia Polyandria class and order. Essential character: calyx four or five-parted; corolla none, but a small annular crenulate nectary surrounding the stamens: male, stamens twenty to fifty: female, style scarcely any; stigma trifid; berry dry, subbilocular; seeds two, three-sided. There are two species, *viz.* X. suaveolens and X. orbiculatum.

XYRIS, in botany, a genus of the Triandria Monogynia class and order. Natural order of Ensatæ. Junci, Jussieu. Essential character: corolla three-petalled, equal, crenate; glumes two-valved in a head; capsule superior. There are four species.

Y.

Y, Or y, the twenty-third letter of our alphabet: its sound is formed by expressing the breath with a sudden expansion of the lips from that configuration by which we express the vowel *u*. It is a consonant in the beginning of words, and placed before all vowels, as in *yard*, *yield*, *young*, &c. but before no consonant. At the end of words it is a vowel, and is substituted for the sound of *i*, as in *try*, *descry*, &c. In the middle of words it is not used so frequently as *i* is, unless in words derived from the Greek, as in *chyle*, *empyreal*, &c. though it is admitted into the middle of some pure English words, as in *dying*, *flying*, &c. Y is also a numeral, signifying 150, or, according to Baronius, 159; and with a dash atop, as $\bar{Y}$, it signified 450,000.

YACHT, or YATCH, a vessel with one deck, carrying from four to twelve guns.

YARD, a measure of length used in England and Spain, chiefly to measure cloth, stuffs, &c. See MEASURE.

YARD *land* is taken to signify a certain quantity of land, in some counties being fifteen acres, and in others twenty; in some

twenty-four, and in others thirty and forty acres.

YARDS *of a ship*, are those long pieces of timber which are made a little tapering at each end, and are fitted each athwart its proper mast, with the sails made fast to them, so as to be hoisted up, or lowered down, as occasion serves. They have their names from the masts to which they belong.

There are several sea-terms relating to the management of the yards; as, square the yards; that is, see that they hang right across the ship, and no yard arm traversed more than another: top the yards, that is, make them stand even. To top the main and fore-yards, the clew-lines are the most proper; but when the top-sails are stowed, then the top-sail-sheets will top them.

YARD *arm* is that half of the yard that is on either side of the mast, when it lies athwart the ship.

YARDS also denotes places belonging to the navy, where the ships of war, &c. are laid up in harbour. There are, belonging to his Majesty's navy, six great yards, *viz.* Chatham, Deptford, Woolwich, Portsmouth, Sheerness, and Plymouth; these yards are fitted with several docks, wharfs, launches, and graving places, for the building, repairing, and cleaning of his Majesty's ships; and therein are lodged great quantities of timber, masts, planks, anchors, and other materials: there are also convenient store-houses in each yard, in which are laid up vast quantities of cables, rigging, sails, blocks, and all other sorts of stores, needful for the royal navy.

YARE, among sailors, implies ready or quick; as, be yare at the helm; that is, be quick, ready, and expeditious at the helm. It is sometimes also used for bright by seamen: as, to keep his arms yare; that is, to keep them clean and bright.

YARN, wool or flax spun into thread, of which they weave cloth.

YEAR, the time that the sun takes to go through the twelve signs of the zodiac. See CHRONOLOGY.

YEAR and DAY, is a time that determines a right in many cases; and, in some, works an usurpation, and in others a prescription; as in case of an estray, if the owner, proclamation being made, challenge it not within the time, it is forfeited.

So is the year and day, given in case of appeal; in case of descent after entry or claim; if no claim upon a fine or writ of right at the common law; so if a villain remaining in ancient demesne; of a man sore bruised or wounded; of protections; essoigns in respect of the King's service; of a wreck, and divers other cases.

YEARS, *estate for*. Tenant for term of years is, where a man letteth lands or tenements to another, for a certain term of years agreed upon between the lessor and lessee; and when the lessee entereth by force of the lease, then he is tenant for term of years.

If tenements be let to a man for term of half a year, or for a quarter of a year, or any less time, this lessee is respected as tenant for years, and is styled so in some legal proceedings, a year being the shortest term which the law in this case takes notice of.

Generally, every estate which must expire at a period certain and prefixed, by whatever words created, is an estate for years, and therefore this estate is frequently called a term, because its duration or continuance is bounded, limited, and determined. For every such estate must have a certain beginning and certain end. If no day of commencement be named in the creation of this estate, it begins from the making or delivery of the lease. A lease for so many years as such an one shall live, is void from the beginning, for it is neither certain, nor can it ever be reduced to a certainty, during the continuance of the lease. And the same doctrine holds, if a parson make a lease of his glebe for so many years as he shall continue parson of such a church, for this is still more uncertain. But a lease for twenty or more years, if the parson shall so long live, or if he shall so long continue parson, is good; for there is a certain period fixed, beyond which it cannot last, though it may determine sooner, on the parson's death, or his ceasing to be parson there.

An estate for years, though never so many, is inferior to an estate for life. For an estate for life, though it be only for the life of another person, is a freehold; but an estate, though it be for a thousand years, is only a chattel, and reckoned part of the personal estate. For no estate of freehold can commence in *futuro*, because it cannot be created at common law without livery of seisin, or corporal possession of the land; and corporal possession cannot be given of an estate now, which is not to commence now, but hereafter. And because no livery of seisin is necessary for a lease for years, such a lessee is not said to be seised, or to

have true legal seisin of the lands. Nor, indeed, doth the bare lease vest any estate in the lessee, but only gives him a right of entry on the tenement, which right is called his interest in the term; but when he has actually so entered, and thereby accepted the grant, the estate is then, and not before, vested in him, and he is possessed not properly of the land, but of the term of years, the possession or seisin of the land remaining still in him who has the freehold.

YELLOW *earth*, named by Werner, gelberde, is of a yellow ochre colour of various degrees of intensity. It is massive, soft and friable: it adheres strongly to the tongue and feels greasy. It occurs in beds with iron-stone in Upper Saxony, and is employed as a yellow pigment.

YELLOW, *Naples*, a fine pigment so called from the city in which it was long prepared. It has the appearance of an earth, is very friable, heavy, porous, and not altered by exposure to the air. The preparation is kept a secret, but by analysis it is found to be a metallic oxide. A similar pigment may be produced by mixing twelve parts of ceruss: three of diaphoretic antimony, and of alum and sal-ammoniac one part each: heat them for some time to a temperature below redness, and afterwards in a red heat for three hours longer, after which the mass will have acquired a beautiful yellow colour.

YEOMAN, is defined to be one that hath fee land of 40*s*. a year; who was thereby, heretofore, qualified to serve on juries, and can yet vote for knights of the shire, and do any other act where the law requires one that is *probus et legalis homo*. Below yeomen are ranked tradesmen, artificers, and labourers.

YEST, YEAST, or BARM, a head, or scum rising upon beer or ale, while working or fermenting in the vat. See BREWING, FERMENTATION, &c.

It is used for a leaven or ferment in the baking of bread, as serving to swell or puff it up very considerably in a little time, and to make it much lighter, softer, and more delicate. When there is too much of it, it renders the bread bitter. See BAKING and BREAD.

Yeast consists of gluten, sugar, and mucilage, with some alcohol, and a portion of malic, acetic, and carbonic acids; but the essential parts of yeast are gluten mixed with a vegetable acid, and therefore dried yeast, which must have lost some of its component parts, is fit for fermentation equally with that which is fresh and new.

YEW. See TAXUS.

YTTRIA. See ITTRIA.

YUCCA, in botany, *Adam's needle*, a genus of the Hexandria Monogynia class and order. Natural order of Coronariæ. Liliа, Jussieu. Essential character: corolla bell-shaped, spreading; style none; capsule three-celled. There are four species.

YUNX, the *wry-neck*, in natural history, a genus of birds of the order Picæ. Generic character; bill somewhat round, slightly incurvated and weak; nostrils bare and rather concave; tongue long, slender, and armed at the point; tail, of ten flexible feathers; feet formed for climbing; toes two before and two behind. There is only one species.

Y. torquilla, or the wry-neck, is allied in some respects to the woodpecker, and in others to the cuckow. It is about the size of a lark, and its colours, though not glaring, are mingled with extreme neatness, and even elegance. It makes no nest, but lays eight or ten eggs on the bare wood in hollow trees. In England it is a bird of passage, generally appearing about ten days before the cuckow. Its food consists chiefly of ants, which during incubation the male may be observed carrying to the female. The young on experiencing any annoyance utter a hissing noise, which excites the idea of some venomous reptile, and has frequently proved their security from destruction. At the end of summer the wry-neck is extremely plump and fat; and is considered by some as little inferior to the ortolan for the table. It is never seen in flocks, and in pairs only during the spring and summer, after which each individual has its solitary haunt in this country, and withdraws unaccompanied in its flight in its winter migration.

Z.

Z, Or z, the twenty-fourth and last letter, and the nineteenth consonant of our alphabet; the sound of which is formed by a motion of the tongue from the palate downwards and upwards to it again, with a shutting and opening of the teeth at the same time. This letter has been reputed a double consonant, having the sound *ds*; but some think with very little reason; and, as if we thought otherwise, we often double it, as in *puzzle*, *muzzle*, &c. Among the ancients, Z was a numeral letter, signifying two thousand, and with a dash added a-top, $\bar{Z}$ signified two thousand times two thousand, or four millions. In abbreviations this letter formerly stood as a mark for several sorts of weights: sometimes it signified an ounce and a half, and very frequently it stood for half an ounce; sometimes for the eighth part of an ounce, or a dram troy weight; and it has, in earlier times, been used to express the third part of one ounce, or eight scruples. ZZ were used by some of the ancient physicians to express myrrh, and at present they are often used to signify zinziber, or ginger.

ZAFFER. See Cobalt.

ZAMIA, in botany, a genus of the Appendix Palmæ class and order. Natural order of Palmæ. Filices, Jussieu. Essential character: male, ament strobile-shaped; scales covered with pollen underneath: female, ament strobile-shaped, with scales at each margin; berry solitary. There are five species.

ZANNICHELLIA, in botany, so named in honour of Giov. Jeronymo Zannichelli, a genus of the Monœcia Monandria class and order. Natural order of Inundatæ. Naiades, Jussieu. Essential character: male, calyx none; corolla none: female, calyx one-leafed; corolla none; germs four or more; seeds as many, pedicelled; stigmas peltate. There is only one species, viz. Z. palustris, horned pondweed, a native of Europe.

ZANONIA, in botany, so named in memory of Giacomo Zanoni, prefect of the botanic garden at Bologna, a genus of the Dioecia Pentandria class and order. Natural order of Cucurbitaceæ, Jussieu. Essential character: calyx three-leaved; corolla five-parted: female, styles three; berry three-celled, inferior; seeds two in each cell. There is but one species, viz. Z. indica, a native of Malabar.

ZEA, in botany, a genus of the Monoecia Triandria class and order. Natural order of Gramina or Grasses. Essential character: males in distinct spikes; calyx glume two-flowered, awnless; corolla glume two-flowered, awnless: female, calyx glume one flowered, two-valved; corolla glume four-valved; style one, filiform, pendulous; seeds solitary, immersed in an oblong receptacle. There is but one species, viz. Z. mays, Indian corn, or maize, and several varieties. The Indians in New England, and many other parts of America, had no other vegetable but maize, or Indian corn, for making their bread. They call it weachin, and in the United States of America there is much of the bread of the country made of this grain, not of the European corn. In Italy, Germany, Spain, and Portugal, maize constitutes a great part of the food of the poor inhabitants. The ear of the maize yields a much greater quantity of grain than any of our corn-ears. There are commonly about eight rows of grain in the ear, often more, if the ground is good. Each of these rows contains at least thirty grains, and each of these gives much more flour than a grain of any of our corn. The grains are usually either white or yellowish; but sometimes they are red, bluish, greenish, or olive-coloured, and sometimes striped and variegated. This sort of grain, though so essentially necessary to the natives of the place, is yet liable to many accidents. It does not ripen till the end of September; so that the rains often fall heavy upon it while on the stalk, and birds in general peck it when it is soft and unripe. Nature has, to defend it from these accidents, covered it with a thick husk, which keeps off slight rains very well; but the birds, if not frightened away, often eat through it, and devour a great quantity of the grain.

ZEBRA. See Equus.

ZENITH, in astronomy, the vertical point; or a point in the heavens directly over our heads. The zenith is called the pole of the horizon, because it is ninety degrees distant from every point of that circle. See Pole and Horizon.

Zenith-*distance* is the complement of

the meridian altitude of any heavenly object; or it is the remainder, when the meridian altitude is subtracted from ninety degrees.

ZENO, in biography, a Greek philosopher of considerable eminence, was born in the isle of Cyprus. He was founder of the Stoics, a sect which had its name from that of a portico at Athens, where Zeno was accustomed to deliver his discourses. The father of our philosopher was a merchant, but readily seconded his son's inclinations, and devoted him to the pursuits of literature. In the way of business he had frequent occasion to visit Athens, where he purchased for his son several of the most renowned works of the celebrated Socratic philosophers. These Zeno read with avidity, and determined to visit the city where so much wisdom was found. Upon his first arrival in Athens, going accidentally into the shop of a bookseller, he took up the commentaries of Xenophon, with the perusal of which he was so much delighted, that he asked the bookseller where he might meet with such men. Crates, the cynic philosopher, was at that moment passing by; the bookseller pointed to him, and said, follow that man. He immediately became his disciple, but was soon dissatisfied with his doctrine, and joined himself to other philosophers, whose instructions were more accordant to his way of thinking. Zeno staid long with no master; he studied under all the most celebrated teachers, with a view of collecting materials from various quarters for a new system of his own. To this Polemo alluded when he saw Zeno coming into his school; "I am no stranger," said he, "to your Phenician arts, I perceive that your design is to creep slily into my garden, and steal away the fruit." From this period Zeno avowed his intention of becoming the founder of a new sect. The place which he chose for his school was the painted porch, the most famous in Athens. Zeno excelled in that kind of subtle reasoning which was in his time very popular. Hence his followers were very numerous, and from the highest ranks in society. Among these was Antigonus Gonates, king of Macedon, who earnestly solicited him to go to his court. He possessed so large a share of esteem among the Athenians, that on account of his integrity, they deposited the keys of their citadel in his hands: they also honoured him with a golden crown and a statue of brass. He lived to the age of 98, and at last, in consequence of an accident, voluntarily put an end to his life. As he was walking in his school, he fell down and broke his finger, by which, it is said, he was so much affected, that, striking the earth, he exclaimed, "Why am I thus importuned? I obey thy summons," and immediately went and strangled himself. In morals, the principal difference between the cynics and the stoics was, that the former disdained the cultivation of nature, the latter affected to rise above it. In physics, Zeno received his doctrine from Pythagoras and Heraclitus, through the channel of the Platonic school. See ACADEMIES, CYNICS, &c.

ZEOLITE, in mineralogy, a species of the flint genus, divided into five subspecies, viz. the mealy, fibrous, radiated, foliated, and cubic zeolite, distinguished from each other by fracture, hardness, and lustre. The mealy is yellow, or reddish-white, is found in Iceland, Ferro islands, Sweden, and in some parts of Scotland, particularly in the isle of Skye; it consists of

Silica	50
Alumina	20
Lime	8
Water	22
	100

The other sub-species vary in their proportions of the same substances. The cubic intumesces like borax before the blowpipe, and melts readily into cellular glass, and during fusion emits a phosphoric light. With acid it forms a jelly. It occurs in rocks of the newest floetz trap, (See ROCK) as amygdaloid, basalt, wacce, porphyry, slate, and greenstone. All the different sub-species of zeolite are found in Scotland, and in the neighbouring islands. They are also met with in great perfection and beauty in Iceland, the Ferro islands, and in several parts of Sweden: and in many parts of Germany, and in the East Indies.

ZEUS, the *dory*, in natural history, a genus of fishes of the order Thoracici. Generic character: head compressed, sloping down; upper lip arched by a transverse membrane; tongue in most species subulate: body compressed, broad, somewhat rhomboid, thin, and of a bright colour, gill-membrane with seven perpendicular rays, the lowest transverse; rays of the first dorsal fin filamentous. There are eight species, of which the following are the principal.

Z. faber, or the common dory, has a large oval dusky spot on each side of the

body, and is generally about thirteen inches long, though often far longer, and even weighing ten or twelve pounds. It is found in the Northern, Mediterranean, and Atlantic Seas, is extremely voracious, and subsists on insects, smaller fishes, and ova. It is in the highest estimation for the table in this country, but was little used before the middle of the last century. See Pisces, Plate VI. fig. 6.

Z. insidiator, or the insidious dory, inhabits the fresh waters of India, and is distinguished by its mouth being more lengthened than that of any other species. The lower lip is said to be at pleasure contracted into a tube, through which this fish darts the fluid it takes in at the gills at various insects near the surface, thus embarrassing their wings, and suspending their flight, under which circumstances they easily become its prey.

ZIERIA, in botany, so named in memory of John Zier, a genus of the Tetrandria Monogynia class and order. Natural order of Rutaceæ, Jussieu. Essential character: calyx four-parted; petals four; stamina smooth, placed on glands; styles simple; stigma four-lobed; capsule four, united; seeds arilled. This is one of the twenty new genera from the South Seas, the characters of which are given by Dr. J. E. Smith. It is distinguished by having each of the stamens inserted into a large gland, and consists of shrubs with opposite, ternate leaves, and white flowers.

ZINC, in chemistry and mineralogy, a metal unknown to the ancients, though they were acquainted with calamine, one of its ores, and the effect which this had in converting copper into brass. Zinc has usually been ranked among those metals, which, from their imperfect ductility and malleability, were long denominated semi-metals. It was known, that by uniform pressure zinc might be extended into thin plates, and more lately, it has been discovered, that, at a certain temperature, it has so much malleability and ductility, that it can be lamellated, and drawn into wire. For this invention a patent has been obtained by Messrs. Hobson and Sylvester, to the latter of whom this work has been indebted for certain articles. See the Preface.

The temperature at which zinc possesses these properties is between 210° and 300° of Fahrenheit, and by keeping it in an oven at this heat, it may readily be extended. By annealing, it retains this tenacity as to be easily bent. At a higher temperature it is brittle, so as to fall to pieces under the hammer. Zinc is of a white colour, with a shade of blue, in a fresh fracture it is possessed of considerable lustre. It is hard, and not easily cut with a knife. The specific gravity is nearly 7.2. The ores of zinc are calamine and blende. See Calaminaris. Calamine is an oxide, frequently with a portion of carbonic acid; blende is a sulphuret, containing also some iron, and other extraneous matters. The ores of zinc are found in many countries, and in a number of mines in this country. The metal is obtained from the ore by distillation.

Zinc is melted by a moderate heat, and the fused mass, on cooling, forms regular crystals. Though scarcely altered by exposure to the air at a low temperature, yet it is rapidly oxydized by one amounting to ignition. When kept in a degree of heat barely sufficient for its fusion, zinc becomes covered with a grey oxide. But when thrown into a crucible, or deep earthen pot, heated to whiteness, it suddenly inflames, burns with a beautiful white flame, and a white and light oxide sublimes, having a considerable resemblance to carded wool. This oxide, however, when once deposited, is no longer volatile; but, if exposed to a violent heat, runs into glass. Zinc readily dissolves in sulphuric, nitric, and muriatic acids. With nitric acid, it yields nitrous gas, if the acid be concentrated; or nitrous oxide, if diluted. Sulphuric and muriatic acids, diluted with water, evolve, during their action on this metal, hydrogen gas; and the gas, when obtained, holds in combination a portion of the metal. A stream of it has been found, if recently prepared, to occasion the fusion of the platina wire, though the pure gas is destitute of this property. This hydrogen gas, holding zinc, in solution, may also be obtained by a process of Vauquelin. A mixture of the ore of zinc, called blende, or calamine, with charcoal, is to be put into a porcelain tube, which is to be placed horizontally in a furnace, and, when red-hot, the vapour of water is to be driven over it. The gas that is produced, however, is a mixture of carbonic acid, carburetted hydrogen, and hydro-zincic gas. The zinc is deposited on the surface of the water, by which this gas is confined; but, if burned when recently prepared, the gas exhibits, in consequence of this impregnation, a blue flame. The solution of zinc in

sulphuric acid shoots into regular crystals. This salt is readily soluble, and its solution is not precipitated by any other metal. The muriate of zinc yields, when evaporated, an extract of thick consistence, having the viscidity of bird-lime. Zinc is oxydized also, when boiled with solutions of pure alkalies; and a portion of the oxide is retained in solution. It is oxydized when mixed with nitre, and projected into a red-hot crucible. In this case a violent detonation ensues.

Zinc combines with almost all the metals, and some of its alloys are of great importance. It may be united to gold in any proportion by fusion. The alloy is the whiter and the more brittle, the greater quantity of zinc it contains. An alloy, consisting of equal parts of these metals, is very hard and white, receives a fine polish, and does not tarnish readily. It has therefore been proposed as very proper for the specula of telescopes. One part of zinc is said to destroy the ductility of one hundred parts of gold. Platinum combines very readily with zinc. The alloy is brittle, pretty hard, very fusible, of a blueish-white colour, and not so clear as that of zinc. The alloy of silver and zinc is easily produced by fusion. It is brittle, and has not been applied to any use. Zinc may be combined with mercury, either by triturating the two metals together, or by dropping mercury into melted zinc. This amalgam is solid. It crystallizes when melted, and cooled slowly into lamellated hexagonal figures, with cavities between them. They are composed of one part of zinc, and two and a half of mercury. It is used to rub on electrical machines, in order to excite electricity.

Zinc combines readily with copper, and forms one of the most useful of all the metallic alloys. The metals are usually combined together by stratifying plates of copper, and a native oxide of zinc combined with carbonic acid, called calamine, and applying heat. When the zinc does not exceed a fourth part of the copper, the alloy is known by the name of brass. It is of a beautiful yellow colour, more fusible than copper, and not so apt to tarnish. It is malleable, and so ductile, that it may be drawn out into wire. Its density is greater than the mean. It ought to be by calculation 7.6, but it actually is 8.4 nearly, so that its density is increased by about one tenth. When the alloy contains three parts of zinc and four of copper, it assumes a colour nearly the same with gold, but it is not so malleable as brass. It is then called pinchbeck, prince's metal, or Prince Rupert's metal. Brass was known, and very much valued, by the ancients. They used an ore of zinc to form it, which they called cadmia. Dr. Watson has proved that it was to brass that they gave the name of orichalcum. Their æs was copper, or rather bronze.

It is very difficult to form an alloy of iron and zinc. Malouin has shown that zinc may be used instead of tin to cover iron plates, a proof that there is an affinity between the two metals. Tin and zinc may be easily combined by fusion. The alloy is much harder than zinc, and scarcely less ductile. This alloy is often the principal ingredient in the compound called pewter.

ZINNIA, in botany, so named in honour of John Godofr. Zinn, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: calyx ovate, cylindrical, imbricate; florets of the ray five, permanent, entire; seed down, with two erect awns; receptacle chaffy. There are five species.

ZIRCON, in mineralogy, the name of a genus, containing two species, viz. hyacinth and zircon: the former will be found in the alphabetical arrangement; we therefore proceed to the species zircon, the chief colour of which is grey; but it occurs through all the varieties of green, blue, red, yellow, and brown. It is found commonly in roundish angular pieces, which have almost always rounded angles and edges. It is likewise crystallized. Specific gravity about 4.6. The constituent parts are, according to Klaproth,

Zirconia	69.0
Silica	26.5
Oxide of iron	0.5
Loss	4.0
	100.0

It is infusible without addition by the blow-pipe; with borax it forms a colourless glass. It is found in Ceylon, in the sand of a river, accompanied by crystals of spinelle, tourmaline, ceylanite. It is frequently cut as a precious stone, and employed for various purposes, particularly as an ornament in mourning dress. When it is cut it exhibits, though in a very feint degree, the play of colours of the diamond. Some of the varieties are frequently used by watchmakers in jewelling watches.

ZIZANIA, in botany, a genus of the Monoecia Hexandria class and order. Natural order of Gramina. Gramineæ, Jussieu. Essential character: male, calyx none; corolla glume two-valved, awnless, mixed with the females: female, calyx none; corolla glume two-valved, cowled, awned; style two-parted; seed one, clothed with the plaited corolla. There are two species; viz. Z. aquatica and Z. terrestris.

ZIZIPHORA, in botany, a genus of the Diandria Monogynia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: calyx filiform; corolla ringent, with the upper lip bent back and entire; seeds four. There are four species.

ZODIAC, in astronomy, a broad circle, whose middle is the ecliptic, and its extremes two circles, parallel thereto, at such a distance from it, as to bound or comprehend the excursions of the sun and planets.

The sun never deviates from the middle of the zodiac, *i. e.* from the ecliptic, but the planets all do more or less. Their greatest deviations, called latitudes, are the measure of the breadth of the zodiac, which is broader or narrower, as the greatest latitude of the planets is made more or less; accordingly some make it sixteen, some eighteen, and some twenty degrees broad. The zodiac, cutting the equator obliquely, makes an angle therewith of about 23½°, which is what we call the obliquity of the zodiac, and is the sun's greatest declination.

The zodiac is divided into twelve portions, called signs, and those divisions or signs are denominated from the constellations which anciently possessed each part; but the zodiac being immoveable, and the stars having a motion from west to east, those constellations no longer correspond to their proper signs, whence arises what we call the precession of the equinoxes.

ZOEGEA, in botany, a genus of the Syngenesia Polygamia Frustranea class and order. Natural order of Compositæ Capitatæ. Cinarocephalæ, Jussieu. Essential character: calyx imbricate; corolla of the ray ligulate; down bristle-shaped; receptacle bristly. There is but one species, viz. Z. leptaurea, a native of the Levant.

ZOISITE, in mineralogy, is of a greyish colour. It occurs massive, and in crystals, which are imbedded. It occurs in primitive mountains, principally in quartz with mica. This fossil is placed between the axinite and pistazite, and connects both species together.

ZONE, in geography and astronomy, a division of the terraqueous globe, with respect to the different degrees of heat found in the different parts thereof. A zone is the fifth part of the surface of the earth, contained between two parallels. The zones are denominated torrid, frigid, and temperate. The torrid zone is a band surrounding the terraqueous globe, and terminated by the two tropics. Its breadth is 46° 58′. The equator, running through the middle of it, divides it into two equal parts, each containing 23° 29′. The ancients imagined the torrid zone uninhabitable. The temperate zones are two bands, environing the globe, and contained between the tropics and the polar circles: the breadth of each is 43° 2′. The frigid zones are segments of the surface of the earth, terminated, one by the antarctic, and the other by the arctic circle. The breadth of each is 46° 58′.

ZONITES, in natural history, a genus of insects of the order Coleoptera: antennæ testaceous; four feelers filiform; jaw entire, longer than the feelers; lip emarginate. There are eight species, found chiefly in warm countries.

ZOOLOGY, constitutes that branch of natural history which relates to animals. Various methods of arrangement have, by different naturalists, been devised to render this branch of study easy of comprehension, and familiar to the minds of those who wish for a general view of animated nature. We shall, in this article, give an outline of the Linnæan system, which has, in the various departments of the British Encyclopedia, been adopted, as most generally approved by our own countrymen, and by many philosophers of all countries.

Linnæus divides the whole animal kingdom into six classes, the characters of which are taken from the internal structure of the being treated of. It may be observed, that a considerable portion of the bulk of animals is composed of tubular vessels, which originate in a heart: the heart propels through the arteries, with the assistance of their own muscular powers, either a colourless transparent fluid, or a red blood, into the extremities of the veins; through which it again returns to the origin of motion. Insects and worms have their circulating fluids a little warmer than the surrounding medium, and in general it is colourless; but insects have legs furnished with joints, and worms have nothing but simple tentacula at most, in place of legs. Fishes have cold red blood, which is exposed to the air

contained in water by means of their gills. Amphibia receive the air into their lungs, but their blood is likewise cold, and in both fishes and amphibia the heart has only two regular cavities, while that of animals with warm blood has four. Of the latter, the oviparous are birds, and are generally covered with feathers, the viviparous are either quadrupeds or cetaceous animals, and are furnished with organs for suckling their young. See PHYSIOLOGY.

Each of the classes of animals is subdivided by Linnæus into different orders: for a scientific account of these orders, and also of the classes from whence they spring, the reader is referred to the several heads of the Dictionary in the alphabetical order; and here we shall take a cursory view of the subject, in order to give, in a short compass, a sort of outline of the science.

The first class, denominated Mammalia, from the female's suckling its young, comprehends all viviparous animals with warm blood. These, with very few exceptions, have teeth fixed in their jaw bones; and from the form and number of these teeth, the orders are distinguished, except that of cetaceous fishes, which is known by the fins that are found in the place of feet. The distinctions of the teeth are somewhat minute, but they appear to be connected with the mode of life of the animal, and they are tolerably natural. The first order, Primates, contains man, monkeys, and bats: the second, Bruta; among others, the elephant, the rhinoceros, the ant-eater, and the ornithorhynchus, an extraordinay quadruped, lately discovered in New Holland, with a bill like a duck, and sometimes teeth inserted behind it; but there are some suspicions that the animal is oviparous. The order Feræ contains the seal, the dog, the cat, the lion, the tiger, the weasel, and the mole, most of them beasts of prey; the opossum and the kangaroo also belong to this order, and the kangaroo feeds on vegetables, although its teeth are like those of carnivorous animals. The fourth order, Glires, comprehends beavers, mice, squirrels, and hares: the fifth, Pecora, camels, goats, sheep, and horned cattle. The sixth order, Belluæ, contains the horse, the hippopotamus, and the hog. The cetaceous fishes, or whales, form the seventh and last order; they reside in the water, enveloped in a thick clothing of fat, that is, of oily matter, deposited in cells, which enables their blood to retain its temperature, notwithstanding the external contact of a dense medium considerably colder.

Birds are distinguished from quadrupeds by their laying eggs; they are also generally feathered, although some few are rather hairy, and instead of hands, or fore-legs, they have wings. Their eggs are covered by a calcareous shell; and they consist of a white, or albumen, which nourishes the chick during incubation, and a yolk, which is so suspended within it, as to preserve the side on which the little rudiment of a chicken is situated, continually uppermost, and next to the mother that is sitting on it. The yolk is, in great measure, received into the abdomen of the chicken a little before the time of its being hatched, and serves for its support, like the milk of a quadruped, and like the cotyledons of young plants, until the system is become sufficiently strong for extracting its own food out of the ordinary nutriment of the species.

Birds are divided, according to the form of their bills, into six orders: Accipitres; as eagles, vultures, and hawks. Picæ; as crows, jackdaws, humming birds, and parrots. Anseres; as ducks, swans, and gulls. Grallæ; as herons, woodcocks, and ostriches. Gallinæ; as peacocks, pheasants, turkies, and common fowls. And, lastly, Passeres; comprehending sparrows, larks, swallows, thrushes, and doves. The Amphibia are in some respects very nearly allied to birds: but their blood is little warmer than the surrounding medium. Their respiration is not necessarily performed in a continual succession of alternations since the whole of their blood does not pass through the lungs, and the circulation may continue without interruption in other parts, although it may be impeded in these organs, for want of the motion of respiration. They are very tenacious of life; it has been asserted on good authority, that some of them have lived many years without food, inclosed in hollow trees, and even in the middle of stones: and they often retain vestiges of life some days after the loss of their hearts. Their eggs are generally covered with a membrane only. They have sometimes an intermediate stage of existence in which all their parts are not yet developed, as we observe in the tadpole; and in this respect they resemble the class of insects. They are now universally considered as divided into two orders only; Reptilia: as the tortoise, the dragon, or flying lizard, the frog, and the toad; all these have four feet: but the animals which belong to the order Serpentes are without feet. Most of the serpentes are perfectly

innocent, but others have fangs, by which they instil a poisonous fluid into the wounds that they make. In England the viper is the only venomous serpent, it is known by its dark brown colour, and by a stripe of whitish spots running along its back, but to mankind its bite is seldom, if ever fatal.

The first three classes of animals have lungs, as we have already seen, for respiration, and receive air by the mouth, those which have gills, and red blood, are fishes, residing either in fresh or in salt water, or indifferently in both: their eggs are involved in a membrane, and have no albumen.

Of the six orders of fishes, four have regular gills, supported by little bones, and they are distinguished, according to the place of their ventral fins, into Apodes, as the eel and lamprey Jugulares, as the cod: Thoracici, as the sole and perch, and Abdominales, as the salmon and pike: distinctions which appear to be perfectly artificial, although useful in a systematic arrangement. The two remaining orders are without bones in the gills, those of the one being soft, and of the other cartilaginous or gristly. These are the Branchiostegi and Chondropterygii of Artedi, which Linnæus, from a mistake, classed among the Amphibia. The sun fish, the lump fish, the fishing frog, and the sea horse, are of the former, and the sturgeon, the skate, and the shark, of the latter order.

Insects derive their name from being almost always divided, into a head, thorax, and abdomen, with very slender intervening portions: although these divisions do not exist in all insects. They are usually oviparous, they respire, but not by the mouth, they have a number of little orifices on each side of the abdomen, by which the air is received into their ramified tracheæ, and if these are stopped with oil, they are suffocated. Instead of bones, they have a hard integument or shell. Their mouths are formed on constructions extremely various, but generally very complicated. Fabricius has made these parts the basis of his classification, but from their minuteness in most species, the method is, in practice, insuperably inconvenient: and the only way, in which such characters can be rendered really useful, is when they are employed in the subdivision of the genera, as determined from more conspicuous distinctions. Insects have most frequently jaws, and often several pairs, but they are always so placed as to open laterally or horizontally. Sometimes, instead of jaws, they have a trunk, or proboscis. In general, they pass through four stages of existence, the egg, the larva, or stage of growth, the pupa, or chrysalis, which is usually in a state of torpor or complete inactivity, and the imago, or perfect insect, in its nuptial capacity. After the last change, the insect most frequently takes no food till its death.

The Linnæan orders of insects are the Coleoptera, with hard sheaths to their wings, generally called beetles; the Hemiptera, of which the sheaths are of a softer nature, and cross each other, as grasshoppers, bugs, and plant lice: the Lepidoptera, with dusty scales on their wings, as butterflies and moths, the Neuroptera, as the libellula, or dragon-fly, the may fly, and other insects with four transparent wings, but without stings, the Hymenoptera, which have stings, either poisonous or not, as bees, wasps, and ichneumons, the Diptera, with two wings, as common flies and gnats, which have halteres, or balancing rods, instead of the second pair of wings, and, lastly, the Aptera, without any wings, which form the seventh order, comprehending crabs, lobsters, shrimps and prawns, for these are properly insects; spiders, scorpions, millepedes, centipedes, mites, and monoculi. The Monoculus is a genus including the little active insects found in pond-water, which are scarcely visible to the naked eye, as well as the Molucca crab, which is the largest of all insects, being sometimes six feet long. Besides these there are several genera of apterous insects which are parasitical and infest the human race as well as other animals.

The Vermes are the last and lowest of animated beings, yet some of them are not deficient either in magnitude or in beauty. The most natural division of vermes is into five orders, the Intestina, as earth worms and ascarides, which are distinguished by the want of moveable appendages, or tentacula, from the Mollusca, such as the dew snail, the cuttle fish, the sea anemone, and the hydra, or fresh water polype. The Testacea have shells of one or more pieces, and most of them inhabit the sea, and are called shell fish, as the limpet, the periwinkle, the snail, the muscle, the oyster, and the barnacle. The order Zoophyta contains corallines, sponges, and other compound animals, united by a common habitation, which has the general appearance of a vegetable although of animal origin, each of the little inhabitants, resembling a hydra, or polype, imitating by its extended

arms the appearance of an imperfect flower. The last order, Infusoria, is scarcely distinguished from the Intestina and Mollusca by any other character than the minuteness of the individuals belonging to it, and their spontaneous appearance in animal and vegetable infusions, where we can discover no traces of the manner in which they are produced. The process, by which their numbers are sometimes increased, is no less astonishing than their first production; for several of the genera often appear to divide spontaneously, into two or more parts, which become new and distinct animals, so that in such a case the question respecting the identity of an individual would be very difficult to determine. The volvox, and some of the vorticellæ are remarkable for their continual rotatory motion, probably intended for the purpose of straining their food out of the water: while some other species of the vorticellæ resemble fungi or corallines in miniature.

ZOOPHYTA, in natural history, an order of the class Vermes. Zoophyta are composite animals, holding a medium between animals and vegetables. Most of them take root and grow up into stems, multiplying life in their branches and deciduous buds, and in the transformation of their animated blossoms or polypes, which are endowed with spontaneous motion. Plants, therefore, resemble zoophyta, but are destitute of animation and the power of loco-motion; and zoophyta are, as it were, plants, but furnished with sensation and the organs of spontaneous motion. Of these some are soft and naked, and others are covered with a hard shell: the former are by some naturalists called zoophytes, and the latter are denominated lithophytes. There are fifteen genera, *viz.*

Alcyonium	Madrepora
Antiputhes	Millepora
Cellepora	Pennatula
Corallina	Sertularia
Flustra	Spongia
Gorgonia	Tubipora
Hydra	Tubularia.
Isis	

The coral reefs that surround many islands, particularly those in the Indian Archipelago, and round New Holland, are formed by various tribes of these animals, particularly by the Cellepora, Isis, Madrepora, Millepora, and Tubipora. The animals form these corals with such rapidity, that enormous masses of them very speedily appear where there were scarcely any marks of such reefs before.

ZOSTERA, in botany, a genus of the Monandria Monogynia class and order. Natural order of Inundatæ. Aroideæ, Jussieu. Essential character: spadix linear, within the sheath of the leaves, flower bearing on one side; calyx none, corolla none; anther sessile, opposite to the germ; stigmas two, linear; capsule one-seeded. There is but one species, *viz.* Z. marina, grass-wrack, and many varieties.

ZWINGERA, in botany, so named from Theodorus Zwinger, Professor of Anatomy and Botany at Basil, a genus of the Decandria Monogynia class and order. Natural order of Terebintaceæ, Jussieu. Essential character: calyx five-parted; petals five; filaments widened at the base, hairy; capsule five, coriaceous, one-seeded, inserted into a fleshy receptacle. There is but one species, *viz.* Z. amara, a native of the woods of Guiana.

ZYGIA, in natural history, a genus of insects of the order Coleoptera: antennæ moniliform; feelers equal, filiform; lip elongated, membranaceous; jaw one-toothed. There is only one species, *viz.* Z. oblonga, which is found in the East.

ZYGOPHYLLUM, in botany, *bean-caper*, a genus of the Decandria Monogynia class and order. Natural order of Gruinales. Rutaceæ, Jussieu. Essential character: calyx five-leaved; petals five; nectary ten-leaved, covering the germ, and bearing the stamens; capsule five-celled. There are fourteen species; of these the following may be noticed: Z. fœtidum, fetid bean-caper: the leaves of this plant stand on long footstalks, and diffuse widely a strong foxy smell: it flowers from July to September. The fruiting peduncle turns back, whence its trivial name retrofractum. It is a native of the Cape of Good Hope. Z. morgsana, four-leaved bean-caper: has a shrubby stem, divided into many irregular-jointed branches, rising four or six feet high; leaves thick and succulent, and placed by fours at each joint, two on each side the stalk opposite; the fruit has four membranaceous wings, resembling the sails of a mill. Z. arboreum, tree bean-caper, is a very handsome tree, forty feet high, with a very large, thick, elegant head; trunk upright, dividing into numerous opposite branches; flowers inodorous, large, handsome, which give the tree a most beautiful appearance when in bloom.

CORRECTIONS AND ADDITIONS.

ADHESION, second paragraph: for *about the same time*, read, *about the year* 1713.

ARIANS. For defence of *low Arianism*, read, *defence of Arianism*.

ASTRONOMY. In the fourteenth page of this article, near the top of the first column, read, instead of what is there found, "The diameter at the poles is 7,893 English miles; at the equator it is 7,928 miles."

CAULIS is referred to from ACAULOSE; the reference should have been made to the article BOTANY.

CONCHA. Instead of this, the reference should have been to SHELL.

CORN *laws* is referred to from the article BOUNTY; the reference should have been to the article CORN *trade*.

COUTCHOUC. Read CAOUTCHOUC.

CYCLE is referred to from CALENDAR, but the reference should have been made to CHRONOLOGY, where an account of the several cycles will be found.

EQUATONAL. Read EQUATORIAL.

FISHING *flies* have been referred to from the article ANGLING, and being omitted in the alphabetical order, we add in this place, that a fishing fly is a bait used in angling for various kinds of fish. The fly is either natural or artificial. The chief of the natural flies are the "stone fly," found under hollow stones at the sides of rivers, between April and July; it is brown with yellow streaks, and has large wings: the "green drake," found among stones by river sides; it has a yellow body ribbed with green, it is long and slender, with wings like a butterfly, and is common in the spring: "the oak fly," found in the body of an oak or ash, is of a brown colour, and common during the summer months: the "palmer fly," or worm, found on the leaves of plants, when it assumes the fly state from that of the caterpillar; it is much used in trout fishing: the "ant fly," found in ant hills from June to September: the "May fly" is to be found playing at the river side, especially before rain: and the "black fly," which is to be found upon every hawthorn after the buds are off. There are two ways to fish with natural flies, either on the surface of the water, or a little underneath it. In angling for roach, dace, &c. the fly should be allowed to glide down the stream to the fish, but in very still water the bait may be drawn by the fish, which will make him eagerly pursue it.

There are many sorts of artificial flies to be had at the shops; they are made in imitation of natural flies, and the rules for using them are as follow. Keep as far from the water's edge as may be, and fish down the stream with the sun at your back, the line must not touch the water. In clear rivers the angler must use small flies with slender wings, but in muddy waters a larger fly may be used. After rain, when the waters are muddy, an orange coloured fly may be used with advantage; in a clear day, the fly must be light coloured, and in dark waters the fly must be dark. The line should in general be twice as long as the rod: but, after all, much will depend on a quick eye and active hand. Flies made for catching salmon must have their wings standing one behind the other. This fish is said to be attracted by the gaudiest colours that can be obtained; the wings and tail should be long and spreading.

FRANKS, or *franking letters*, which ought to have been included in the article POST-OFFICE, is a privilege that has been enjoyed by members of parliament from the first institution of the post-office. The original design of this exemption was that they might correspond freely with their constituents on the business of the nation. For many years it was sufficient to frank a letter or packet, that any member of parliament subscribed his name at the bottom of the cover. By degrees, however, this privilege was so much abused, that it was enacted that no letter should pass free, unless the whole direction was in the hand writing of the member, and his subscription annexed: a subsequent act obliges the member to write not only the full direction, but to note the town at which the office is where the letter is sent from. A member of parliament can frank only ten letters on each day, and receive fifteen

free of postage: each of which must weigh less than one ounce.

GAURS. This word having been referred to, it is necessary to mention that the Gaurs are an ancient sect of magicians in Persia, where they are employed in the meanest offices, and vilest drudgery. They are said to be harmless in their manners, zealous in their opinions, rigorous in their morals, and exact in their dealings. They profess the worship of one God alone, the belief of a resurrection, and a future judgment, and utterly detest all idolatry. They perform their acts of worship in the presence of fire, for which they have much veneration, regarding it as the most perfect emblem of the living and invisible God. They exhibit the same marks of respect for Zoroaster that the Jews have for Moses, esteeming him as a prophet sent from God.

GUIAC. Read GUAIACUM.

HOWITZ, or HOWITZER, in military affairs, a kind of mortar mounted upon a field carriage like a gun. The difference between a mortar and a howitzer is, that the trunnions of the first are at the end, and of the other in the middle. The invention of howitzers is of much later date than that of mortars. The construction is various, but the chamber is always cylindrical. They are distinguished by the diameter of the bore. A battery of howitzers is formed in the same way as a gun-battery, only the embrasures are at least a foot wider, on account of the shortness of the howitzer.

JESUITS. In this article, for *Loyoly* and 1738, read *Loyola* and 1538.

LINARIA has been referred to from LINNET, which is a species of FRINGILLA, and under that article the description will be found.

MUSTELA has been referred to from FERRET, &c. but the reference should have been to VIVERRA, where the principal species are described.

NAZARENES, in church history, has been referred to from the article EBIONITES; and being omitted in its proper place, we may observe here, that it was a name originally applied to Christians in general, as followers of Jesus of Nazareth; but was afterwards restrained to that sect who endeavoured to blend the institutions of the Mosaic law with those which are peculiar to the gospel.

NECROMANCY being referred to, we define the term as a species of pretended divination, performed by raising the dead, and extorting answers from them.

PERSICA was referred to from NECTARINE, but the reference should have been to AMYGDALUS, of which genus the persica, or nectarine, is only a species.

PRINTING, *stereotype*. In the second paragraph, for *by* the Jesuits, read *say* the Jesuits. See STEREOTYPE.

STAMP *duties*, a branch of the public revenue, raised by requiring, that all deeds or documents, in order to be valid, shall be written on paper or parchment bearing a public seal for which a tax is paid. This mode of taxation was introduced into England in 1671, by "an act for laying an imposition on proceedings at law;" but the act in 1694 for imposing several duties upon vellum, parchment and paper, may be considered as the commencement of the present Stamp Office, as a particular set of commissioners was then appointed for managing the duties. These duties at first were to continue only for a limited period, but about the year 1698 several new ones were granted to continue for ever, to which, additions, almost without end, have, at different times, been since made, as will appear from the following statement. The total gross produce of the stamp duties, in the year 1713, was 107,779*l*., the charges of management of which amounted to 14,296*l*., leaving a nett produce of only 93,483*l*. In 1723, the nett produce had increased to 130,409*l*.; and it seldom exceeded this amount till 1757, when some new stamp duties were imposed, by which the total nett amount of this revenue was increased to 267,725*l*.: in 1766 it amounted to 285,266*l*.; and no material additions were made till towards the conclusion of the American war. In 1782, a duty was imposed on fire-insurances, which, though not actually collected by means of stamps, was classed with the stamp duties. In 1784, additional duties were laid on gold and silver plate. In 1785, duties were laid on post-horses, quack medicines, game-licenses, attorneys' licenses, and pawnbrokers; all of which were deemed stamp duties, and considerably augmented the annual amount. But a far greater increase took place in the course of the war which began in 1793, during which new stamp duties were imposed on receipts, bills of exchange, attorneys' articles, sea-insurances, licenses to wear hair-powder, horse-dealers' licenses, legacies, hats, stage-coaches, deeds, armorial bearings, small

notes, medicines, and several other articles, which soon increased this branch of the revenue to more than double its former amount; and it is a mode of taxation which it is in general so difficult to evade, and is attended with such a comparatively small expense in collecting, that there can be little doubt that it will be extended as far as possible.

The total produce of stamp duties of Great Britain the year ending in January, 1806, was 4,194,285*l.* 12*s.* 10½*d.* This sum was subject to some deductions, but when these were made, the produce was little less than four millions sterling. The expense of collection amounts to 3¼ per cent on the gross revenue. The following are some of the principal stamp duties in which the public are most interested, payable after the 10th of October, 1808.

RECEIPTS, BILLS OF EXCHANGE, &c.

	l.	*s.*	*d.*
Receipt for the payment of money amounting to 2*l.* and under 10*l.*	0	0	2
To 10*l.* and under 20*l.*	0	0	4
To 20*l.* and under 50*l.*	0	0	8
To 50*l.* and under 100*l.*	0	1	0
To 100*l.* and under 200*l.*	0	2	0
To 200*l.* and under 500*l.*	0	3	0
To 500*l.* or upwards	0	5	0
In full of all demands	0	5	0

N. B. Any general acknowledgment of the settlement of any account or debt, where the amount is not specified, is liable to the duty of 5*s.*

Inland Bill of Exchange, draft, or order for payment to bearer, or order, on demand, or otherwise:

	l.	*s.*	*d.*
Amounting to 40*s.* and not exceeding 5*l.* 5*s.*	0	1	0
Above 5*l.* 5*s.* to 30*l.*	0	1	6
Above 30*l.* to 50*l.*	0	2	0
Above 50*l.* to 100*l.*	0	3	0
Above 100*l.* to 200*l.*	0	4	0
Above 200*l.* to 500*l.*	0	5	0
Above 500*l.* to 1,000*l.*	0	7	6
Above 1,000*l.* to 3,000*l.*	0	10	0
Above 3,000*l.*	1	0	0

N. B. Every species of order, or receipt, which, being given as a consideration for money, enables the payee to receive the sum expressed therein from a third person, is considered as a bill of exchange; excepting drafts to *bearer on demand* drawn on any banker residing within 10 miles of the place where the same is drawn, provided the place be specified thereon. Bank bills and bank post bills, and bills drawn for wages, &c. of navy and army, are exempted from the duty.

Foreign Bill of Exchange, if drawn singly, the same duty as the inland bill. Drawn in sets: for every bill of each set not

	l.	*s.*	*d.*
Exceeding 100*l.*	0	1	0
Above 100*l.* to 200*l.*	0	2	0
Above 200*l.* to 500*l.*	0	3	0
Above 500*l.* to 1,000*l.*	0	4	0
Above 1,000*l.* to 3,000*l.*	0	5	0
Above 3,000*l.*	0	10	0

Promissory Note to bearer on demand, (intended to be re-issued):

	l.	*s.*	*d.*
Not exceeding 1*l.* 1*s.*	0	0	4
Above 1*l.* 1*s.* to 2*l.* 2*s.*	0	0	8
Above 2*l.* 2*l.* to 5*l.* 5*s.*	0	1	0
Above 5*l.* 5*l.* to 20*l.*	0	1	6
Above 20*l.* to 30*l.*	0	3	0
Above 30*l.* to 50*l.*	0	4	6
Above 50*l.* to 100*l.*	0	7	6

Promissory Note in any other manner than to bearer on demand, (not re-issuable):

	l.	*s.*	*d.*
Amounting from 40*s.* to 5*l.* 5*s.*	0	1	0
Above 5*l.* 5*s.* to 30*l.*	0	1	6
Above 30*l.* to 50*l.*	0	2	0
Above 50*l.* to 100*l.*	0	3	0

Promissory Note, either to bearer on demand, or in any other manner, (not re-issuable):

	l.	*s.*	*d.*
Above 100*l.* to 200*l.*	0	4	0
Above 200*l.* to 500*l.*	0	5	0
Above 500*l.* to 1,000*l.*	0	7	6
Above 1,000*l.* to 3,000*l.*	0	10	0
Above 3,000*l.*	1	0	0

PROBATES OF WILLS, OR LETTERS OF ADMINISTRATION.

			l.	*s.*
Above the value of 20*l.* and under 100*l.*			0	10
Of 100*l.*	and under	200*l.*	2	0
200	......	300	5	0
300	......	450	8	0
450	......	600	11	0
600	......	800	15	0
800	......	1,000	22	0
1,000	......	1,500	30	0
1,500	......	2,000	40	0
2,000	......	3,500	50	0
3,500	......	5,000	60	0
5,000	......	7,500	75	0

CORRECTIONS AND ADDITIONS.

				l.	s.
7,500l. and under		10,000l.	....	90	0
10,000	......	12,500	......	110	0
12,500	......	15,000	......	135	0
15,000	......	17,500	......	160	0
17,500	......	20,000	......	185	0
20,000	......	25,000	......	210	0
25,000	......	30,000	......	260	0
30,000	......	35,000	......	310	0
35,000	......	40,000	......	360	0
40,000	......	45,000	......	410	0
45,000	......	50,000	......	460	0
50,000	......	60,000	......	550	0
60,000	......	70,000	......	650	0
70,000	......	80,000	......	750	0
80,000	......	90,000	......	850	0
90,000	...	100,000	......	950	0
100,000	...	125,000	...	1,200	0
125,000	...	150,000	...	1,400	0
150,000	...	175,000	...	1,600	0
175,000	...	200,000	...	2,000	0
200,000	...	250,000	...	2,500	0
250,000	...	300,000	...	3,000	0
300,000	...	350,000	...	3,500	0
350,000	...	400,000	...	4,000	0
400,000	...	500,000	...	5,000	0
500,000		or upwards	....	6,000	0

Probates, &c. of seamen, marines, or soldiers; exempted.

LEGACIES.

All legacies, pecuniary or specific, out of personal estate, or charged on real estate; and all residues of personal estate, whether devised by will or accruing by succession, and all shares and residues arising from the sale of real estate under a will. If the value amounts to or exceeds 20l. a duty per cent as follows:

To children of the deceased, or their descendants, 1l.

To a brother or sister of the deceased, or their descendants, 2l. 10s.

To a brother or sister of the deceased's father or mother, or their descendants, 4l.

To a brother or sister of the deceased's grandfather or grandmother, or their descendants, 5l.

To any collateral relation, or to a stranger in blood, 10l.

The husband or wife of the deceased is exempt from the above duties.

ANNUAL LICENCES.

Licence to appraiser (not a licensed auctioneer) annual, 6s.

To any banker, &c. who shall issue any promissory note payable on demand, and be re-issuable, 20l.

For selling medicines, &c. liable to duty under said act, 44 George III. c. 98, (usually called quack medicines):

In London or Westminster, (or within the two-penny post), and in Edinburgh, 2l.

In any other city, borough, or town corporate, or in Manchester, Birmingham or Sheffield, 10s. In any other place, 5s.

For exercising the trade of a pawnbroker:

In London or Westminster, or two-penny post district, 10l. In any other place, 5l.

By postmasters or persons letting to hire horses for travelling post, by the mile, or from stage to stage, or for a day, or for any less period than 28 days, for drawing carriages used in travelling post, 5s.

By persons keeping public stage coaches or carriages, for each carriage so kept:

If carrying 4 inside passengers, 5s.

More than 4 and not more than 6, 6s.

More than 6 and not more than 8, 7s.

More than 8 and not more than 10, 8s.

More than 10, 9s.

Children in lap are excepted from the several numbers.

PROCEEDINGS IN THE COURTS.

Duties on *Law Proceedings*, in the courts, to be paid in respect of every skin, sheet, &c. except where they are imposed according to the number of words, or otherwise expressly charged.

MISCELLANEOUS.

As fellow of the College of Physicians, in England or Scotland, 20l.

By license from the College of Physicians to practise within seven miles of the metropolis, 10l.

Matriculation in any university in Great Britain, 10s.

To the degree of batchelor of arts in ordinary course, 3l.

By special grace, royal mandate, or nobility, or otherwise out of ordinary course, 5l.

Any other degree in the ordinary course of the university, 6l. Out of the ordinary course, 10l.

To the degree of M. D. in either of the universities in Scotland, 10l.

Advertisements in the London Gazette or any public newspaper, 3s.

Agreement, or Memm. of Agreement, made in England under hand only, or in Scotland without any clause of registration, and not otherwise charged nor expressly exempted in the schedule; the matter thereof being of the value of 20l. or upwards, and containing not more than 1,080

words, including any schedule, &c. 16s. Containing more than 1,080 words, 1l. 10s. And further for every 1,080 words beyond the first 1,080, 1l.

Almanack or *Calendar* for the year, or less, 1s. If for more years, then for each year for which it shall serve, 1s. Perpetual Almanack, 10s.

Calendars or perpetual almanacks, in bibles or prayer books, excepted.

Appraisement of estate, real or personal, in any case whatsoever, except appraisement by order of an admiralty court, amount not exceeding 50l., 2s. 6d.—Exceeding 50l. to 100l., 5s.—Exceeding 100l. to 200l., 10s. —Exceeding 200l. to 500l., 15s.—Exceeding 500l., 1l.

Articles of Apprenticeship and Clerkship. Any profession or trade, &c. except attornies and others specifically charged, where the premium does not amount to

			l.	s.	d.
30l.			0	15	0
30l.	and under	50l.	1	10	0
50l.		100l.	2	10	0
100l.		200l.	5	0	0
200l.		300l.	10	0	0
300l.		400l.	15	0	0
400l.		500l.	20	0	0
500l.		600l.	25	0	0
600l.		800l.	30	0	0
800l.		1,000l.	40	0	0
1,000l. or upwards			50	0	0

Bond in England, and personal bond in Scotland, as security for a definite sum

			l.	s.
Not exceeding	100l.		1	0
Exceeding	100l. to	300l.	1	10
....	300l.	500l.	2	0
....	500l.	1,000l.	3	0
....	1,000l.	2,000l.	4	0
....	2,000l.	3,000l.	5	0
....	3,000l.	4,000l.	6	0
....	4,000l.	5,000l.	7	0
....	5,000l.	10,000l.	9	0
....	10,000l.	15,000l.	12	0
....	15,000l.	20,000l.	15	0
....	20,000l.		20	0

Where the total amount of the money secured, or to be ultimately recoverable, shall be uncertain, being for money to be hereafter advanced, or to become due on account current, 20l.

Certificate to be taken out yearly, by attornies, solicitors, or proctors, in England; and by writers to the signet, solicitors, agents, attornies, or procurators, in any of the courts in Scotland; notaries public in England and Scotland; and also by every sworn clerk, clerk in court, and other officer, who shall act in any of the above capacities for any other emolument than the regular emolument of the office: when residing within the limits of the two-penny post in England, or within the city or shire of Edinburgh, and if he shall have been admitted 3 years or upwards, 10l. Or if not so long admitted, 5l. When residing elsewhere; and admitted for three years, or upwards, 6l. Or if not so long admitted, 3l.

Conveyance (whether grant, assignment, transfer, renunciation, or of any other description whatever) on the sale of any lands, rents, or other property, real or personal, heritable or moveable, or of any right, title, interest, &c. in the same; for the principal or only deed whereby such property shall be granted or conveyed to or vested in the purchaser, &c.

Where the purchase-money (which shall be truly expressed therein) shall not amount to 50l., 15s.

			l.	s.
To	50l. and not to	150l.	1	0
	150l.	300l.	1	10
	300l.	500l.	2	10
	500l.	750l.	5	0
	750l.	1,000l.	7	10
	1,000l.	2,000l.	10	0
	2,000l.	3,000l.	20	0
	3,000l.	4,000l.	30	0
	4,000l.	5,000l.	40	0
	5,000l.	7,500l.	50	0
	7,500l.	10,000l.	75	0
	10,000l.	15,000l.	100	0
	15,000l.	20,000l.	150	0
	20,000l.	30,000l.	200	0
	30,000l.	40,000l.	300	0
	40,000l.	50,000l.	400	0
	50,000l. or upwards		500	0

Grant of the dignity of a Duke, 200l.; Marquis, 200l.; Earl, 200l.; Viscount, 150l.; Baron, 100l.; and Baronet, 50l. Of a congé d'elire, 20l. Of the royal assent to the election of Archbishop or Bishop, 20l.

Grant under the great or privy seal from the civil list, &c. (not part of annual supplies or voted by Parliament):

			l.	s.
Under	100l.		1	10
......	100l. and not	250l.	4	0
......	250l.	500l.	10	0
......	500l.	750l.	20	0
......	750l.	1,000l.	30	0
	1,000l. or upwards, for every 100l. thereof		5	0

Of any annuity or pension,			l.	s.
Under	100l. per annum		1	10
......	100l. and not	200l.	4	0
......	200l.	400l.	10	0
......	400l.	600l.	20	0
......	600l.	800l.	30	0
......	800l.	1,000l.	40	0
......	1,000l. or upwards		50	0

But in cases of renewal only, 1l. 10s.

Grant, of any office or employment, by letters patent, deed, or other writing, the salary, fees, &c. not amounting to

50l. per annum		1	10
50l. and not	100l.	3	0
100l.	200l.	5	0
200l.	300l.	10	0
300l.	500l.	20	0
500l.	750l.	30	0
750l.	1,000l.	40	0
1,000l.	1,500l.	50	0
1,500l.	2,000l.	75	0
2,000l.	3,000l.	100	0
3,000l. per ann. or upwards		150	0

Mortgage, conditional surrender by way of mortgage, &c. wadset, conveyance in trust, defeasance, or other deed, intended as a security by way of mortgage, where the same shall be made, as a security for the payment of any definite sum of money, advanced or lent at the time, or previously due and owing, or forborne to be paid, being payable,

				l.	s.
Not exceeding 50l.				0	15
Exceeding	50l.	to	100l.	1	0
....	100l.	...	150l.	1	10
....	150l.	...	300l.	2	0
....	300l.	...	500l.	3	0
....	500l.	...	1,000l.	4	0
....	1,000l.	...	2,000l.	5	0
....	2,000l.	...	3,000l.	6	0
....	3,000l.	...	4,000l.	7	0
....	4,000l.	...	5,000l.	8	0
....	5,000l.	...	10,000l.	10	0
....	10,000l.	...	15,000l.	12	0
....	15,000l.	...	20,000l.	15	0
....	20,000l.			20	0

This *ad valorem* duty is chargeable only on *one part* of the mortgage deed, the other being liable as a common deed. It is not chargeable on mortgages made merely for further assurance, in cases where the *ad valorem* duty has been paid on other deeds.

Newspapers, (For every half sheet double demy, or sheet of single demy) 3½d.

Pamphlets, of half a sheet or less, ½d. not exceeding a sheet, 1d.

Pamphlets exceeding 1 sheet and not exceeding 6 sheets in octavo, (or on a lesser page) 12 sheets quarto, or 20 sheets folio. For every sheet contained in one copy, 2s.

Acts of parliament, proclamations, orders of council, form of prayer, and acts of state, ordered to be printed by the King; printed votes of parliament, school books, and books of devotion, are exempted.

Passport, 5s.

Plate of Gold, wrought in Great Britain, per oz. and in proportion, 16s. Gold watch cases excepted.

Plate of Silver, wrought in Great Britain, per oz. and so in proportion, 1s. 3d. Except watch cases, chains, and several small articles.

Playing Cards, per pack, 2s. 6d.

Policy of Assurance, on any life or lives, or on any event depending on life or lives, sum insured not amounting to 500l., 15s. Amounting to 500l. or upwards, 1l. 10s.

Specification, of a patent, 5l. And further for 1,080 words, above the first 1,080, 1l.

Stage Coaches and Carriages, carrying passengers for hire, for every mile such carriage shall travel:

If carrying not more than 4 inside passengers, 2d.

If 4 and not exceeding 6, 2½d.
If 6 .... 8, 3½d.
If 8 .... 10, 4d.
More than 10....... ... 5d.

Transfer of Bank or South Sea stock, 7s. 9d.

Of East India stock, 1l. 10s.

Of stock of any other corporation, not otherwise charged under the head of mortgage or conveyance, 1l. 10s.

STRAW *hat manufacture*, is of very modern invention; it has, however, of late years afforded the means of support to a large class of our industrious poor, and of not a few in the middle ranks of life. The manufacture requires but little capital, and the art is quickly acquired. Thirty or forty shillings are said to be sufficient for the purchase of the machines and materials for employing one hundred persons some length of time. The straw used is readily obtained, and when properly sorted it is cut at the joints, and the outer covering being removed, it is then ranged according to the different sizes, and made up into bundles of eight or ten inches in length, and about a foot in circumference. The bundles are then dipped in water, and shaken a little, so as not to retain much moisture;

and then they are to be placed on their edges in a box, which is sufficiently close to prevent the evaporation of the smoke. In the middle of the box is an earthen vessel, containing sulphur, which is set on fire, and the box covered over for several hours. The straws are next to be split, which operation is performed by a small machine made chiefly of wood. When split, the straws are denominated splints, and of these each braider has a certain quantity, which they hold under the arm, and draw them out as wanted. The rules laid down are these: platters should be taught to use their second fingers and thumbs, instead of the fore fingers, which are often required to assist in turning the splints, and very much facilitate the platting, and they should take care not to wet the splints too much. Each platter should have a small linen bag, and a piece of pasteboard to roll the plat round. When five yards are worked up, it is wound about a piece of board, fastened at the top with yarn, and kept there several days to form it in a proper shape. Four of these parcels, or a score, is the measurement by which the plat is sold. When the straw is platted it comes into the hand of the person who sews it together into the form of hats, bonnets, &c. of various shapes and sizes. These are then put on wooden blocks for the purpose of hot pressing: and, to render them of a more delicate white, they are again exposed to the fumes of sulphur.

STURGEON, a species of the Acipenser genus, is referred to, and being omitted in its place, we may briefly observe, that it is a very large fish, of eighteen or twenty feet long, an inhabitant of the northern seas, migrating during the early summer months into the larger rivers and lakes, and returning to the sea again in autumn after having deposited its spawn. It is a fish of slow motion, and is easily taken. It is admired for the delicacy and firmness of the flesh. From the roe is prepared the substance called caviar. In this country the sturgeon annually ascends rivers, but in no great quantities, and is occasionally taken in salmon nets. In its manner of breeding the sturgeon forms an exception among cartilaginous fishes, it being oviparous. The sturgeon was a fish in high repute among the ancients, and was brought to table with much pomp, and ornamented with flowers, the slaves who carried it being likewise adorned with garlands, and accompanied with music. The flavour of the sturgeon is said to vary with the food on which it is chiefly fed, hence it is distinguished in the North of Europe into mackrel-sturgeon, herring sturgeon, &c. See Shaw's "Zoology."

SUBSTANCES, *simple*. To this article references have been made, and it having been omitted in the alphabetical order, we must not pass it by here. In other cases we are grieved that haste or negligence should have required these additions and corrections, in this we have reason for different emotions, having by the omission an opportunity of stating some facts, and some results, which have not been made public more than two or three days.

In the language of modern chemistry, the term simple substances has a different signification from that attached to it in ancient philosophy. By elements, or simple substances, was formerly understood primary principles, which were essentially simple and indestructible, which, by modification of form, or by mutual combination, formed the different substances which compose the material world. Modern philosophy pursues a different mode of investigation: it analyses substances, and endeavours to decompose them, or separate them into their constituent parts, and when it arrives at any which it cannot decompose, and beyond which analysis cannot be carried, and whose properties can only be changed by causing them to combine with others, then such substances are denominated simple. This term does not imply their absolute simplicity, because new experiments, or new agents, may be able to reduce certain bodies that at present have not been decomposed into others that are more simple. Till very lately the fixed alkalies, the boracic, fluoric, and muriatic acids were reckoned among the simple substances: to these may be added the metals, the several earths, sulphur, phosphorus, and the diamond.

By the Voltaic battery, in the hands of Mr. Davy, Professor of Chemistry at the Royal Institution, many of these substances, which where deemed simple a few months since, have been decomposed. For his experiments on the alkalies, we refer to the articles ALKALI and POTASSIUM: and on Saturday last, Dec. 17th, he announced in his public lecture, that he had decomposed sulphur and phosphorus, the component parts of which are oxygen and hydrogen, and a metallic base; that charcoal he had found to consist of hydrogen and the carbonaceous principle,

and that diamond was a compound of the carbonaceous principle and oxygen; that he had succeeded in obtaining the metallic base of ammonia, which, when combined with mercury, in the proportion of only $\frac{1}{12000}$th part, rendered the mercury solid, and reduced the specific gravity from 13 to 3. The professor likewise informed his audience, that he had decomposed the boracic and fluoric acids, and had enjoyed a glimpse of their metallic bases; and that he had fully ascertained, that lime, magnesia, strontites, and barytes, are compound bodies, each having a metallic substance as a base. Hence the number of simple substances, which, but a year ago, was estimated by Dr. Thomson at 38, is in a very short space of time considerably reduced. Chemistry, indeed, as a science, will probably undergo a complete renovation: the discoveries of Mr. Davy promise a total overthrow to the beautiful, and as it was formerly deemed, simple and almost perfect system of Lavoisier. The English professor assumes electricity as a general agent of decomposition; that different bodies are naturally in different electrical states; that by altering these states their affinities are altered. In justification of this theory, he has ascertained that oxygen, and all bodies containing an excess of oxygen, are naturally negative, and that all bodies containing an excess of inflammable principle are naturally positive. Should subsequent facts confirm this theory, it is highly probable, that many other of the bodies, hitherto regarded as simple, will yield to the powers of his apparatus.

SUBSTANCES, *imponderable*, in chemistry, are caloric, light, electricity, and galvanism: perhaps the identity of the two former may hereafter be discovered: and likewise that of the two latter more completely demonstrated. The common character that they all possess is, that of not being subject to the attraction of gravitation; at least their gravity has hitherto been incapable of appreciation, hence the term "imponderable." They possess the greatest subtilty, or tenuity; they cannot easily be obtained in a separate state of existence; they are observed only in states of combination, or in their rapid transition from one body to another. We can scarcely discover their specific affinities, or measure their force, and we are unable to trace their particular combinations, or consider them as essential constituent principles of any compound. They are moreover diffused over every kind of matter; at least caloric exists in all bodies, and probably also the electric and galvanic agents. See Murray's Chemistry.

TELESIE, in mineralogy, a gem so named by Haüy, which answers to the perfect CORUNDUM and the SAPPHIRE: to these articles the reader might be referred without further addition, but having directed him already to TELESIE from the article GEM, we shall, in this place, give Mr. Murray's description. It occurs in fragments, and is crystallized; the form of its crystals being the double three-sided pyramid, the single six-sided pyramid, and the six-sided prism, variously modified by truncations and acuminations. Its colours are numerous; blue, green, red, of numerous shades, and yellow or yellowish white, and sometimes more than one colour is present even in the same crystal. It is more or less transparent; its lustre is resplendent and vitreous; and it often presents a beautiful reflection of light, in the form of a star: the fracture is conchoidal, or imperfectly foliated; the hardness is inferior to that of the diamond, but superior to that of every other fossil, and not yielding to the file: the specific gravity is from 3.9 to 4.1.

TIME, *equation of*, the most usual and best measure of time that we have is a clock regulated by the vibration of a pendulum. But with whatever accuracy a clock may be made, it must be subject to irregularities, as well from the imperfection of the workmanship, as from the expansion and contraction of the materials by heat and cold, by which the length of the pendulum, and consequently the time of vibration, will vary. As no clock, therefore, can be depended upon for keeping time accurately, it is necessary that we should be able at any time to ascertain how much it is too fast or too slow, and at what rate it gains or loses. For this purpose it must be compared with some motion which is uniform, or of which, if it be not uniform, one can find the variation. The motions of the heavenly bodies have therefore been considered as most proper for the purpose. Now as the earth revolves uniformly about its axis, the apparent diurnal motion of the heavenly bodies about the axis must be uniform. If a clock, therefore, be adjusted to go 24 hours from the passage of any fixed star over the meridian till it returns to it again, its rate of going may be determined by comparing it with the transit of any fixed star, and observing whether the interval

continues to be 24 hours; if not, the difference shows how much it gains or loses in that time. A clock thus adjusted is said to be adjusted to sidereal time, and all the sidereal days are equal. But all the solar days are not equal, that is, the intervals from the sun's leaving the meridian till it returns to it again, are not all equal, so that if a clock be adjusted to go 24 hours in one interval, another interval will be performed in more or less than 24 hours, and thus the sun and the clock will not agree; that is, the clock will not continue to show 12 when the sun comes to the meridian. It is found that the length of the solar day is equal to the time of the earth's rotation about its axis, together with the time of describing an angle equal to the increase of the sun's right ascension in a true solar day. Now if the sun moved, or appeared to move, uniformly, and in the equator, this increase would be always the same in the same time, and therefore the solar days would be all equal; but the sun moves, or appears to move, in the ecliptic, and therefore, if its motion were uniform, equal arcs upon the ecliptic would not give equal arcs upon the equator. But the apparent motion of the sun in the ecliptic is not uniform, and hence also any arc upon the ecliptic, described in a given time, is subject to a variation, and consequently that on the equator is subject to a variation. The increase then of the sun's right ascension in a true solar day, varies from two causes: first, because the ecliptic, in which the sun appears to move, is inclined to the equator; secondly, because his motion in the ecliptic is not uniform, therefore the length of a true solar day is subject to a continual variation; consequently a clock which is adjusted to go 24 hours for any one true solar day, will not continue to show 12 when the sun comes to the meridian, because the intervals by the clock will continue equal, if the clock be supposed accurate, but the intervals of the sun's apparent passage over the meridian are not equal.

As the sun appears to move through 360° of right ascension in about 365¼ days, therefore 365.25 : 1 day :: 360° : 59′ 8″ 2‴, the increase of right ascension in one day, if the increase were uniform, or it would be the increase in a mean solar day, that is, if the solar days were all equal; for they would be all equal, if the sun's right ascension increased uniformly. As the earth describes an angle of 360° 59′ 8″ 2‴ about its axis in a mean solar day of 24 hours, and an angle of 360° in a sidereal day, we say, as 360° 59′ 8″ 2‴ : 360° :: 24h : 23h 56′ 4″ the length of a sidereal day in mean solar time, or the time from the passage of a fixed star over the meridian till it returns to it again. From these considerations it will be evident, that if a clock be adjusted to go 24 hours in a mean solar day, it will not continue to coincide with the sun, that is, to show twelve when the sun comes to the meridian, because the true solar days differ in length from a mean solar day, but the sun will pass the meridian, sometimes before 12, and sometimes after 12, and this difference is called the equation. A clock thus adjusted, is said to be adjusted to mean solar time. The time shown by the clock is called true or mean time; and that shown by the sun is called apparent time: thus, when the sun comes to the meridian, it is said to be 12 o'clock apparent time. Hence the time shown by the sun-dial is apparent time, and therefore a dial will differ from a clock by how much the equation of time is on that day. When, therefore, we set a clock or watch by the dial, we must attend to what the equation of time is upon that day by a table, such as that given below, and allow for it: thus, if the equation be 4 minutes, as it is on new year's day, and the watch or clock be faster than the sun; then the watch or clock must be made to show 4 minutes past 12 when the dial shows 12 precisely. On the 30th of April, when the dial shows 12, the clock or watch, to be accurate, must want 3 minutes of that hour, and so of the rest. In calculating tables of the equation of time, for every day in the year, the sun and clock are set together, when the sun is in his apogee, and then they investigate the difference between the sun and the clock, for every day at noon, and insert them in a table, stating, by means of the signs + and − how much the clock is before or after the sun. The inclination of the equator to the ecliptic, upon which the equation of time partly depends, and the place of the sun's apogee, when the clock and sun set off together, being both subject to vary, the equation of time for the same days of the year, will every year vary, and therefore it must, where great accuracy is required, be calculated for every year. Besides the time when the sun is in his apogee, there are three other times of the year when the clock and sun agree, or when mean and apparent time is the same, as will be seen

in the followiog table, which is adapted to the second year after Bissextile, and will always be found within a few seconds of the truth, and therefore sufficiently accurate for all common purposes.

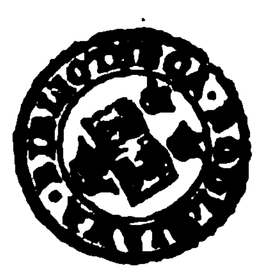
TABLE FOR THE EQUATION OF TIME.

Jan. 1	4 +	April 1	4 +	Aug. 9	5 +	Oct. 27	16 —
3	5	4	3	15	4	Nov. 15	15
5	6	7	2	20	3	20	14
7	7	11	1	24	2	24	13
9	8	15	0	28	1	27	12
12	9	*		31	0	30	11
15	10	19	1 —	*		Dec. 2	10
18	11	24	2	Sep. 3	1 —	5	9
21	12	30	3	6	2	7	8
25	13	May 13	4	9	3	9	7
31	14	29	3	12	2	11	6
Feb. 10	15	June 5	2	15	5	13	5
21	14	10	1	18	6	16	4
27	13	15	0	21	7	18	3
Mar. 4	12	*		24	8	20	2
8	11	20	1 +	27	9	22	1
12	10	25	2	30	10	24	0
15	9	29	3	Oct. 3	11	*	
19	8	July 5	4	6	12	26	1 +
22	7	11	5	10	13	28	2
25	6	28	6	14	14	30	3
28	5			19	15		

TRIGONOMETRY. Some of the references to the figures are not quite correct, bnt the figures speaking so plainly for themselves, a more particular correction is deemed unnecessary.

UNITARIANS. In the third page of this article, for *Polones Fratres*, read *Fratres Poloni*. In the fifth page, for *similar*, read *nearly similar*.

Such, it is believed, are the chief errors and omissions: others of less importance the candid and liberal reader will excuse, and will readily correct for himself.



FINIS.

C. WHITTINGHAM, Printer,
103, Goswell Street.

Fig. 1 Rana [illegible] common Frog. Fig. 2 [illegible] common Toad. Fig. 3 Siren lacertina [illegible] Fig. 4 Testudo [illegible]

[illegible]

Plate XIII

Fig. 1 Rallus aquaticus Water rail. Fig. 2 Ramphastos [illegible] Yellow throated toucan. Fig. 3 Rynchops nigra Skimmer. Fig. 4 Recurvirostra [illegible]. Fig. 5 Scolopax rusticola Woodcock. Fig. 6 Scolopax [illegible]. Fig. 7 Sterna minuta Lesser tern.

[illegible]

Plate XII

Fig. 1 Struthio camelus Black ostrich. Fig. 2 Tantalus melanocephalus Black headed ibis.
Fig. 3 Trochilus [illegible] Humming bird. Fig. 4 Upupa magna Grand hoopoe.
Fig. 5 Vultur papa King vulture.

Fig. 1 Phalaena *Junonia* *Fig.* 2 Phryganea *grandis* *Fig.* 3 Scarabaeus [illegible] *Fig.* 4 S. Hercules *Fig.* 5 Sirex *gigas* *Fig.* 6 Sphex *maculata* *Fig.* 7 Sphinx *atropos* *Fig.* 8 Thrips *physapus* *Fig.* 9 Vespa *vulgaris*

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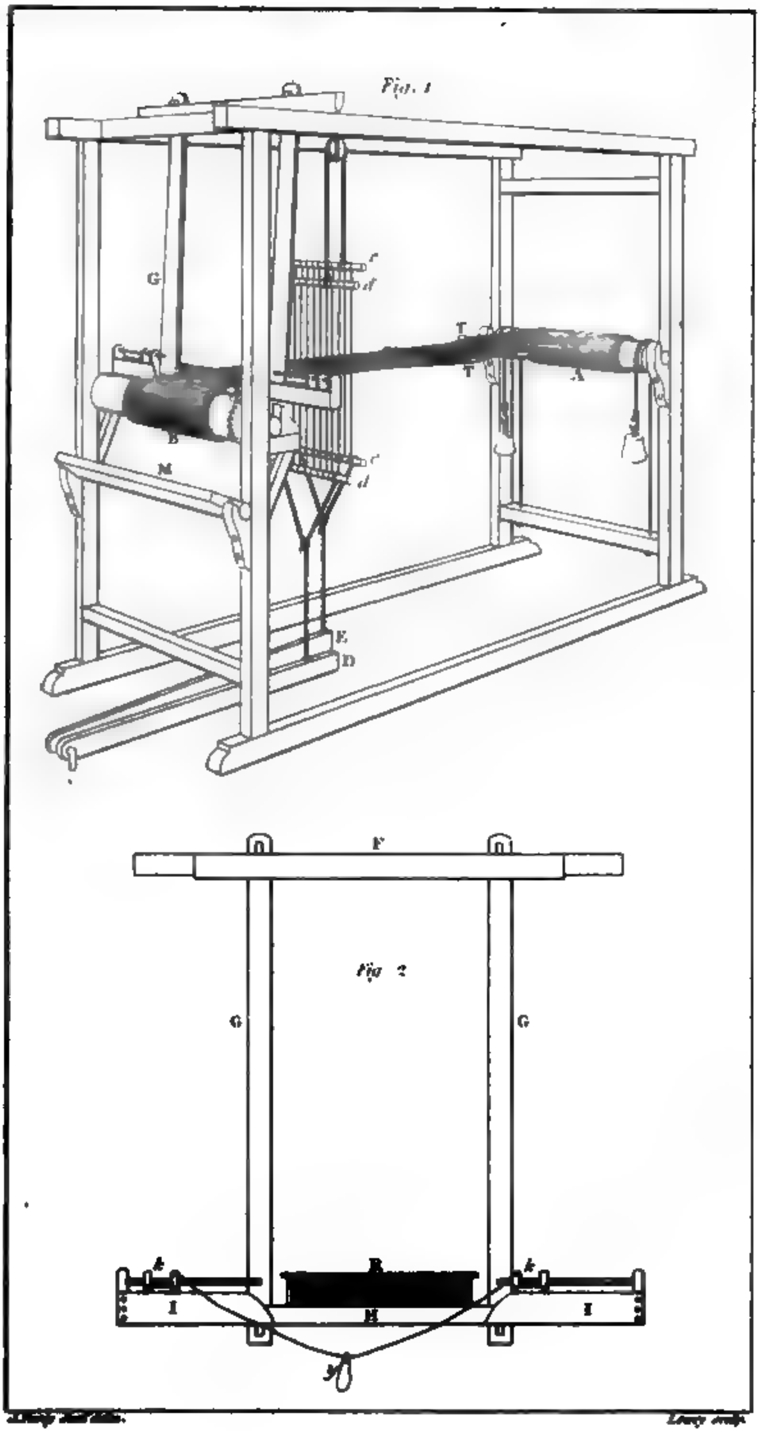

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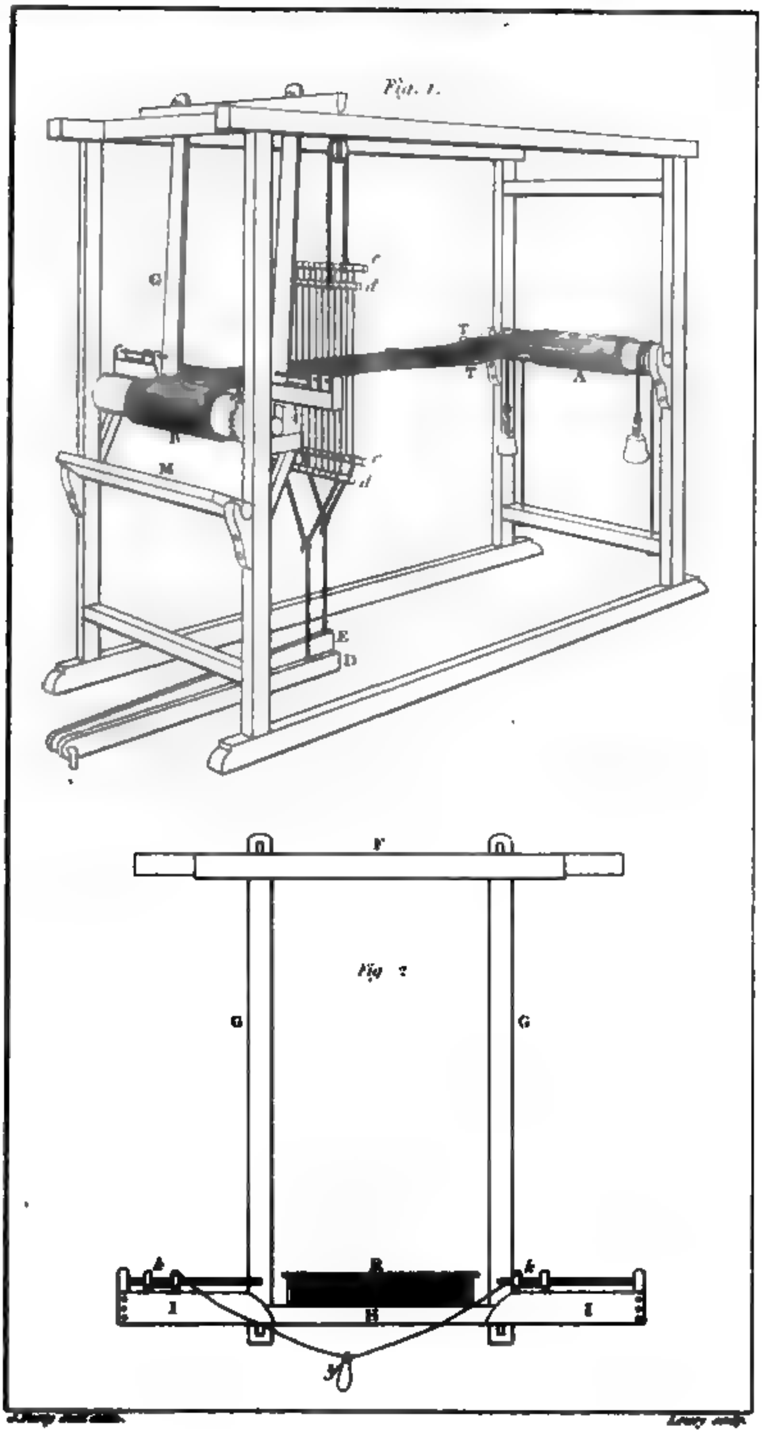

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Fig 1 Sorex minutus minute shrew Fig 2 S radiatus radiated shrew Fig 3 S moschatus musky shrew
Fig 4 Sukotyro Indicus Fig 5 & 6 Talpa Europaea common mole & radiated mole

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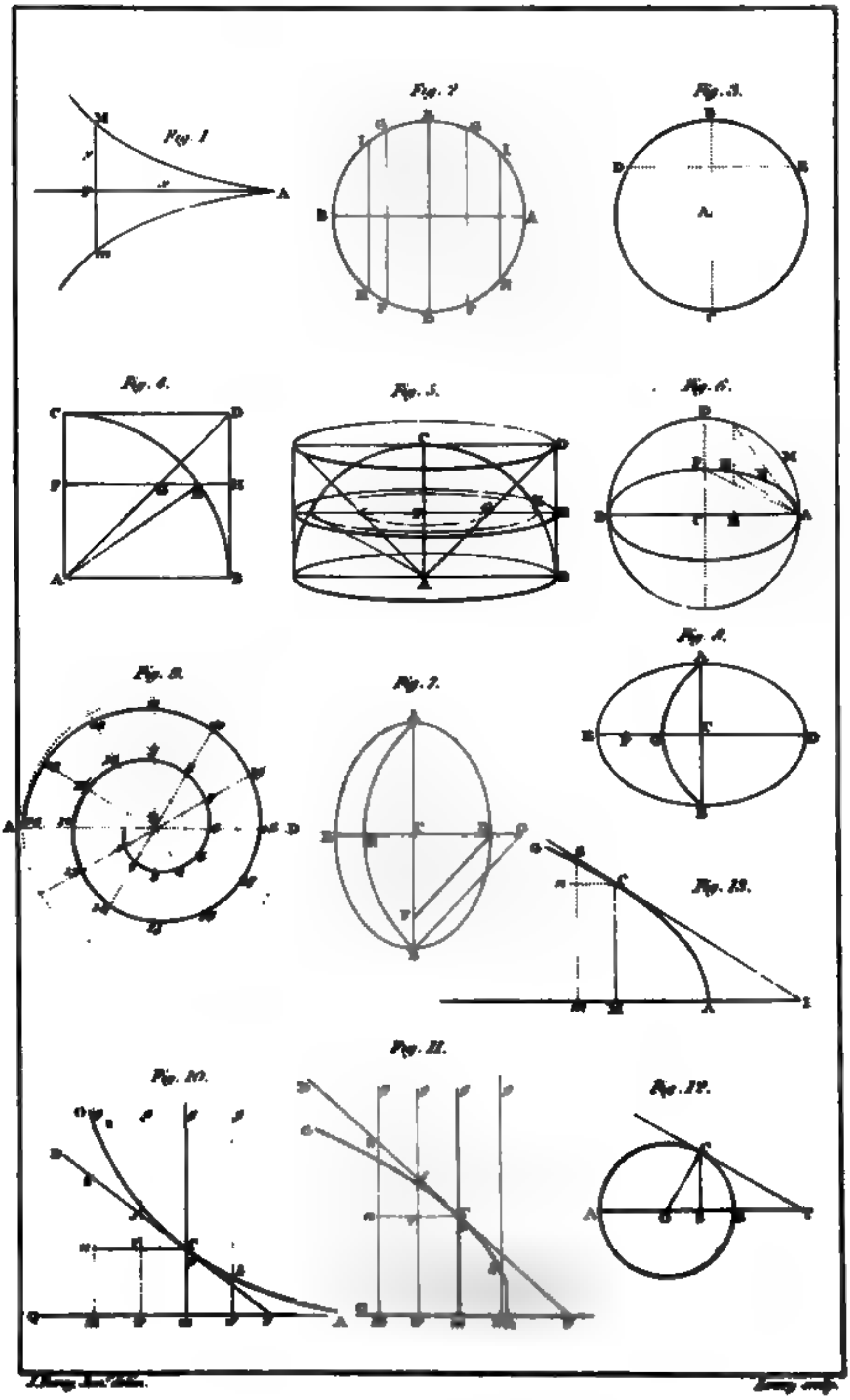
MAMMALIA.

Fig. 1. Sus [illegible] wild boar. Fig. 2. Ursus [illegible] black bear.
Fig. 3. White bear. Fig. 4. Trichechus [illegible] Walrus.

London, Published [illegible] by Longman, Hurst, Rees & Orme, Paternoster Row.



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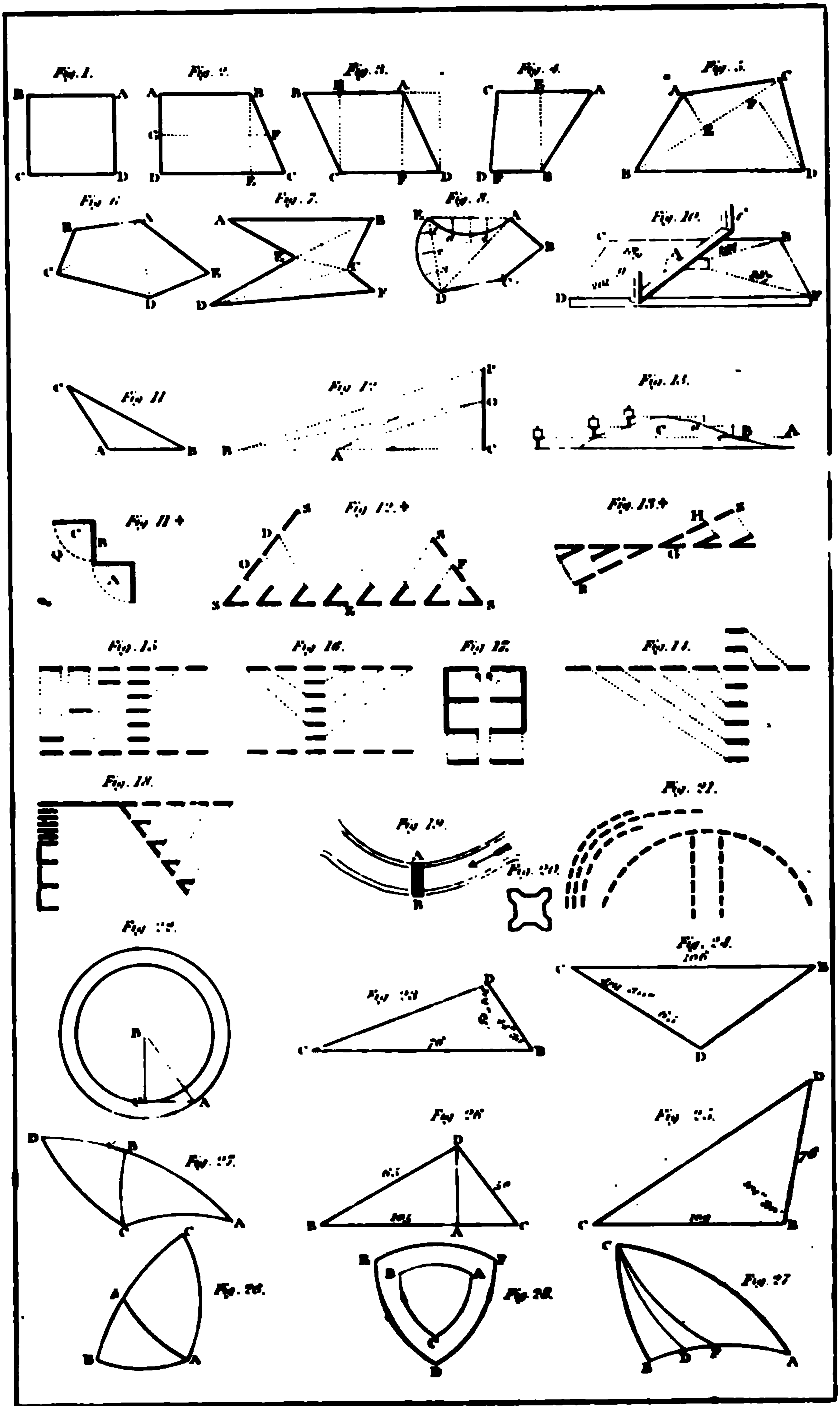
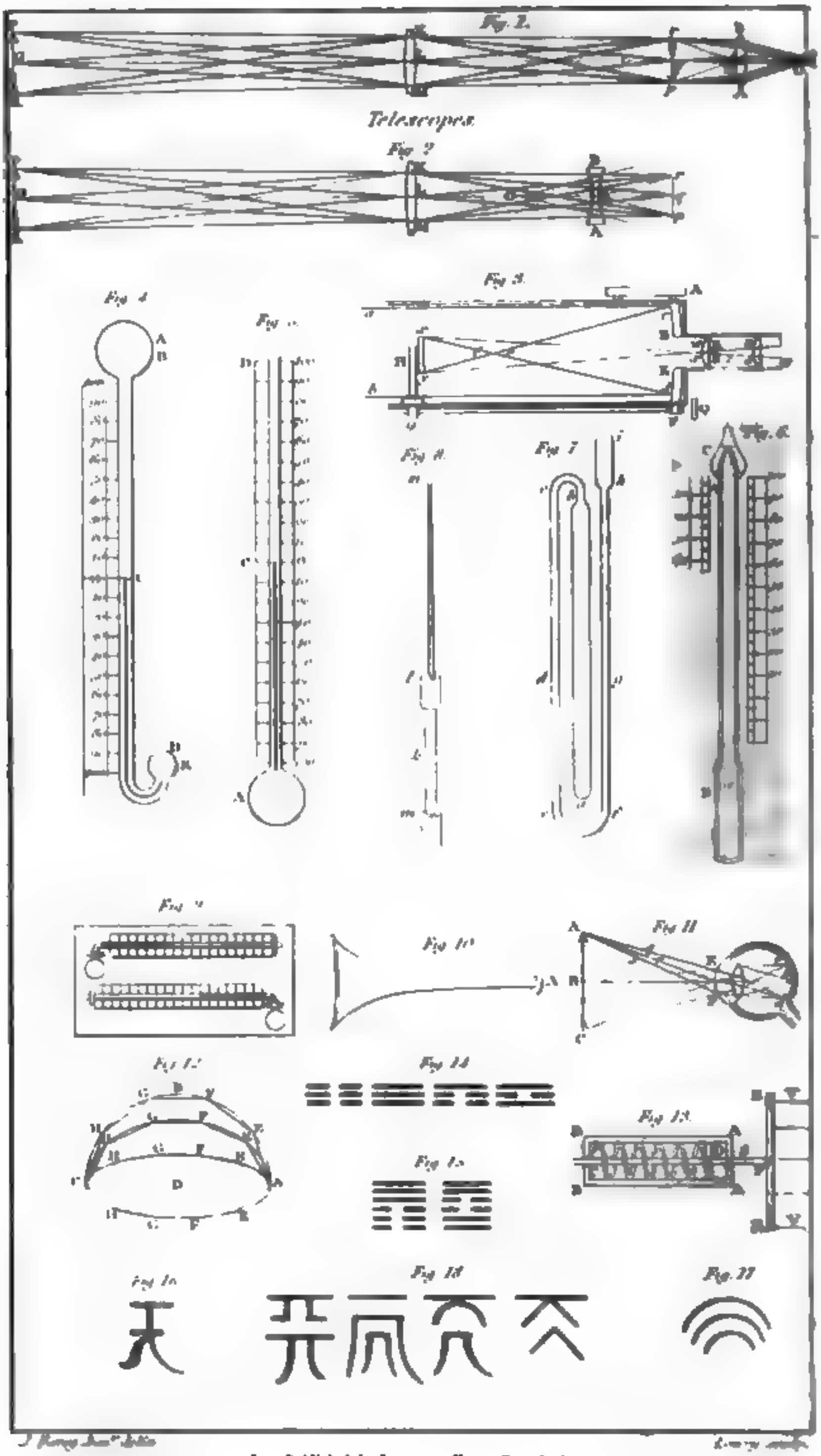


J. Farey Jun.r delin. Lowry sculp.

London. Published by Longman, Hurst, Rees & Orme, 1809.



J. Farey Junr delin. Lowry sculp.

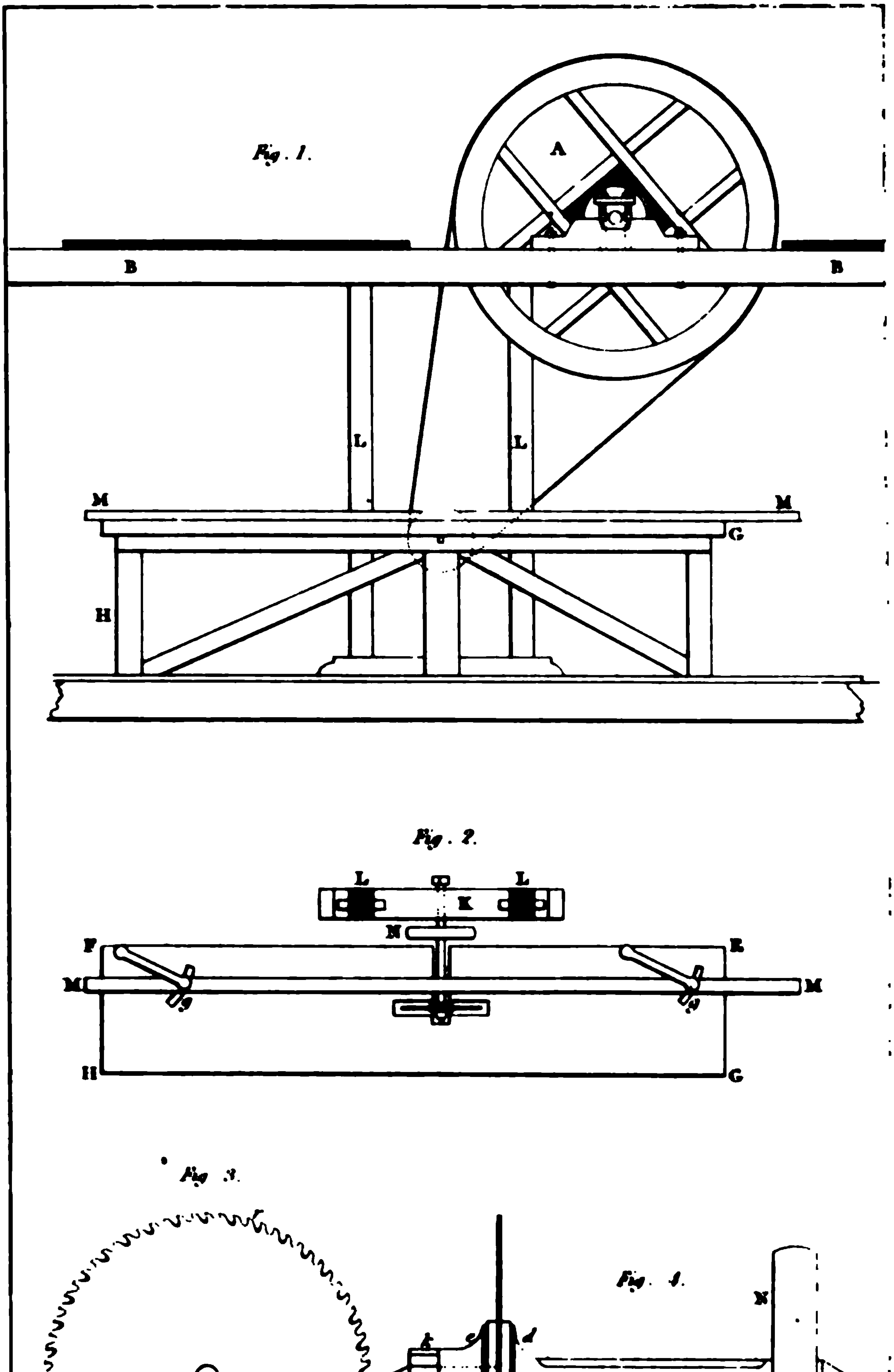
London. Published by Longman, Hurst, Rees & Orme

PISCES. Plate 17

Fig 1 Squalus cinereus basking Shark. Fig 2 Sternoptyx diaphana transparent sternoptyx
Fig 3 Syngnathus foliatus foliated pipe fish. Fig 4 Tetrodon testudineus tortoise shell tetrodon
Fig 5 Xiphias gladius common sword fish. Fig 6 Zeus faber common dory

London Published by Longman Hurst Rees & Orme July 1 1808

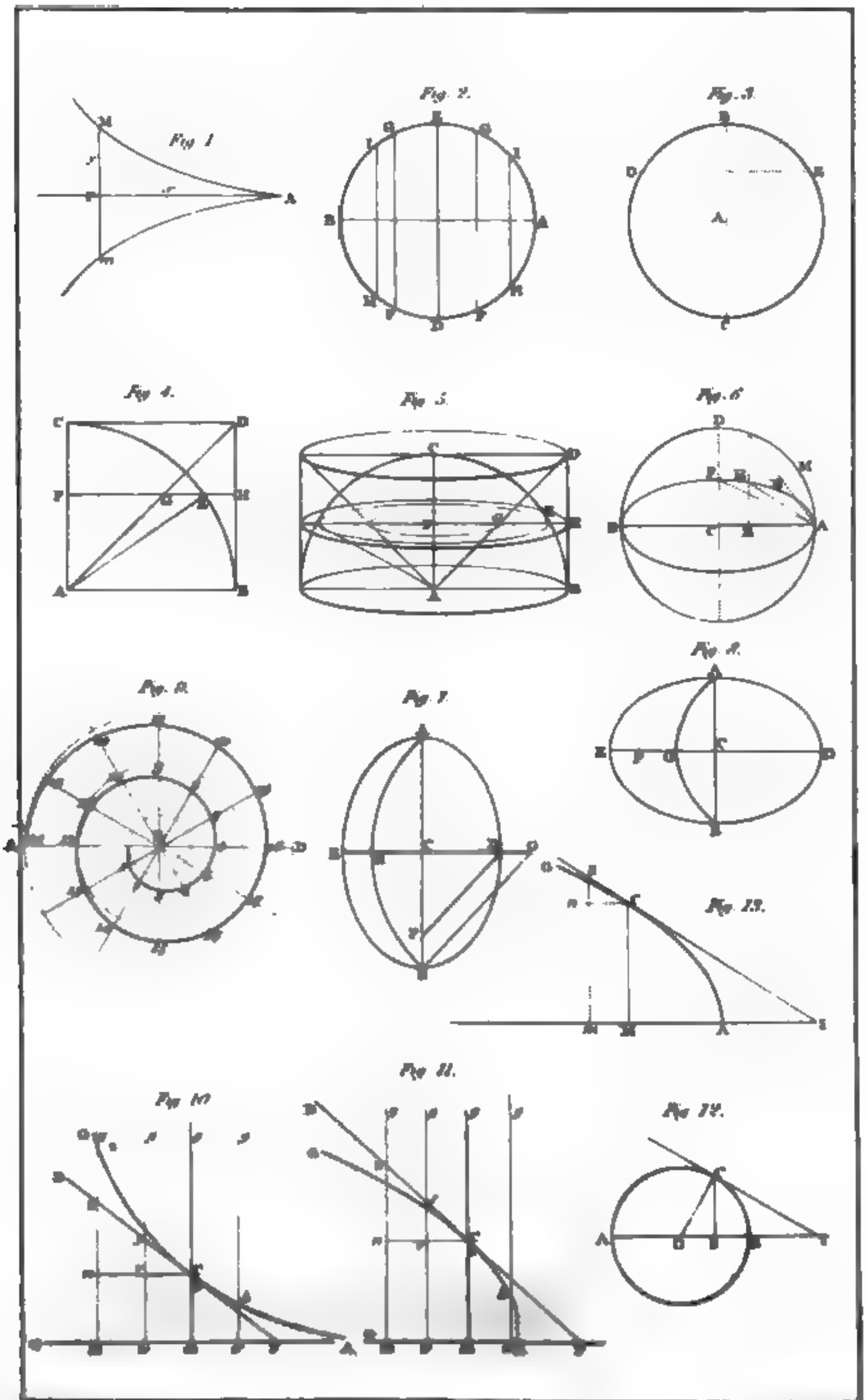
SAW MILL.



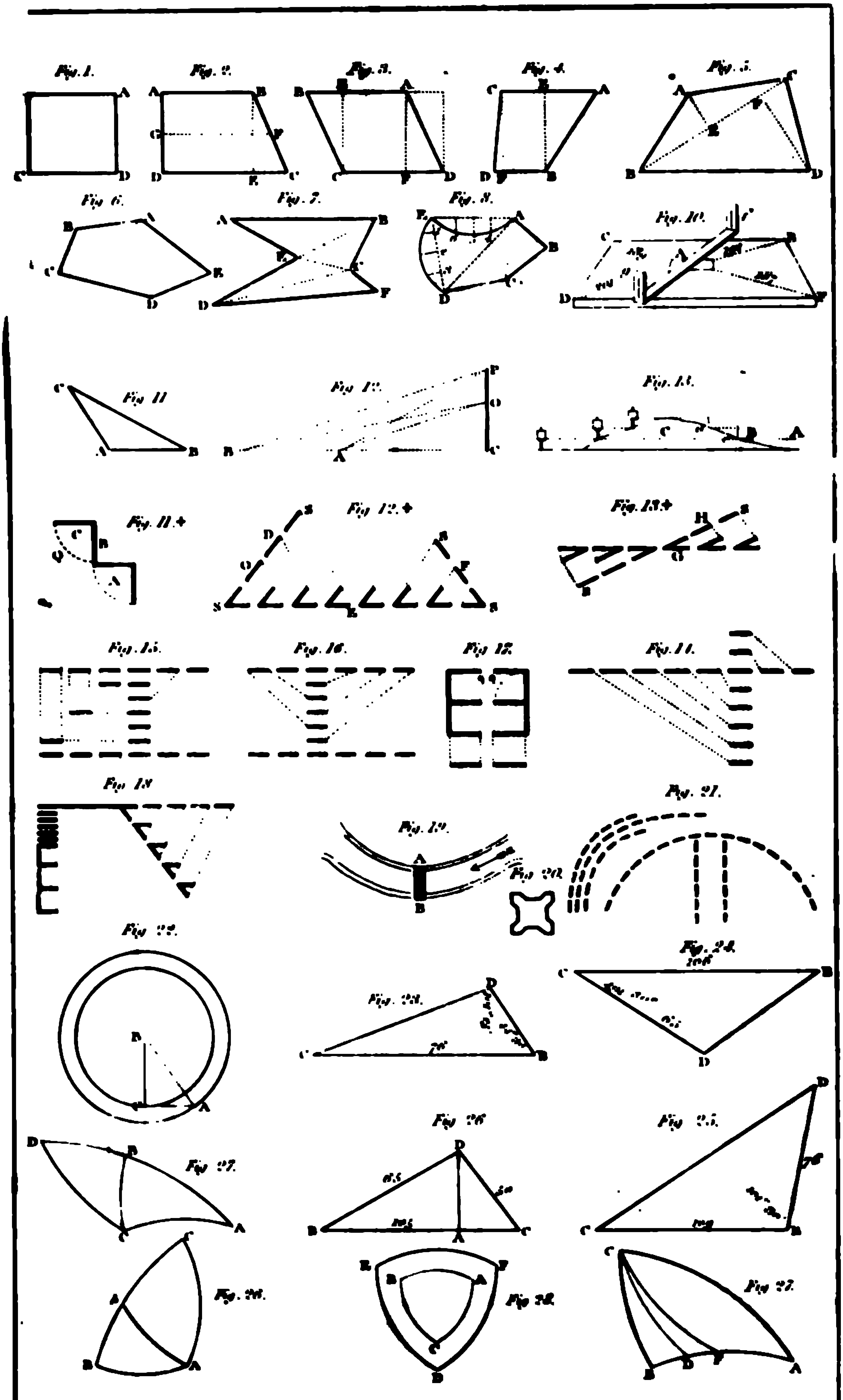
J. Farey Junr. delin.

Lowry sculp.

London. Published by Longman, Hurst, Rees & Orme, Augt. 1808.



London Published by Longman, Hurst, Rees & Orme, 1809.



J. Farey Junr. delin. Lowry sculp.

London. Published by Longman, Hurst, Rees & Orme, 1809.

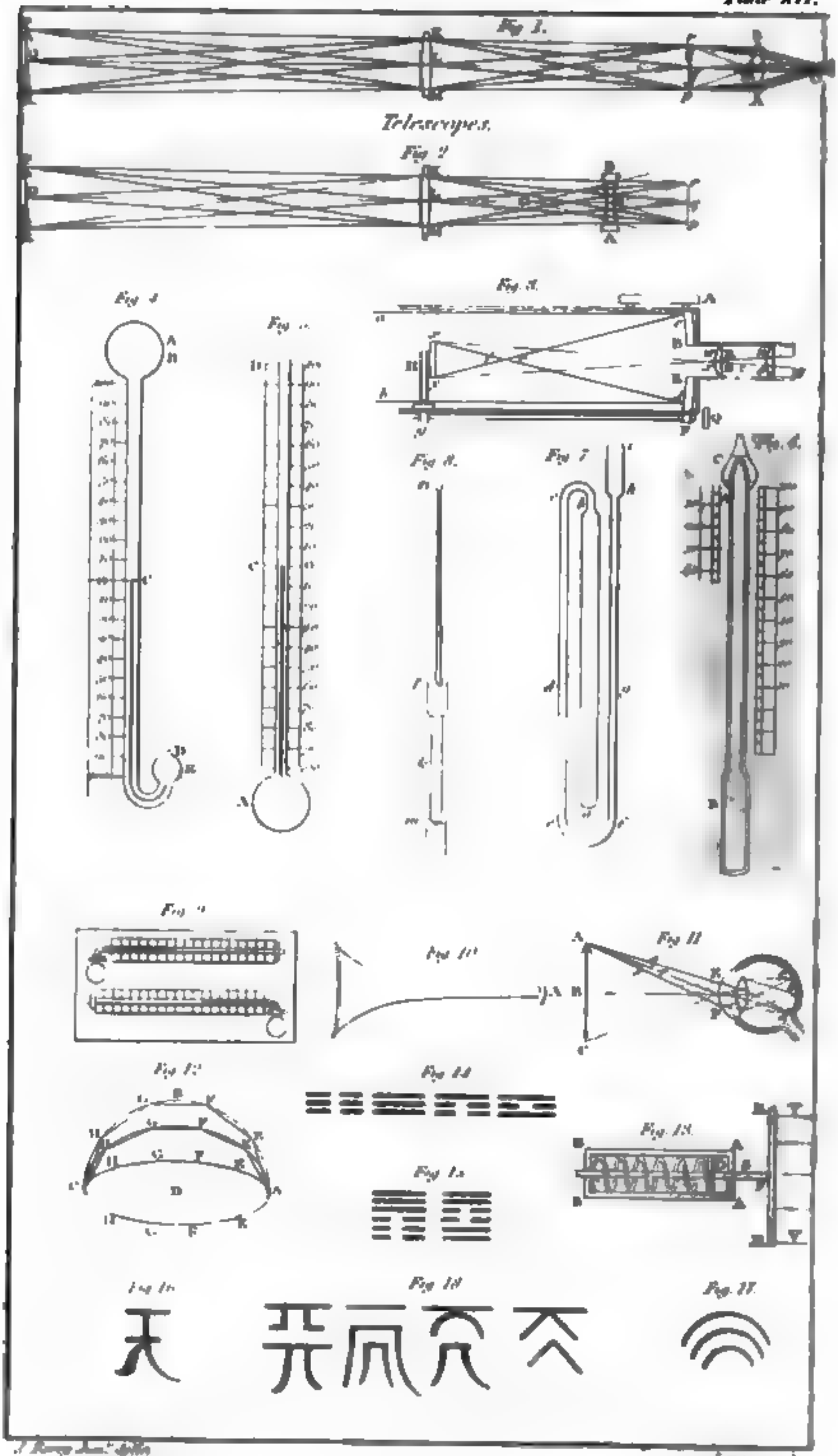


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Fig 1 Squalus *maximus* *basking Shark* *Fig 2* Sternoptyx *diaphana* *transparent sternoptyx*
Fig 3 Syngnathus *foliatus* *foliated pipe fish* *Fig 4* Tetrodon *testudineus* *tortoise shell tetrodon*
Fig 5 Xiphias *gladius* *common sword fish* *Fig 6* Zeus *faber* *common dory*

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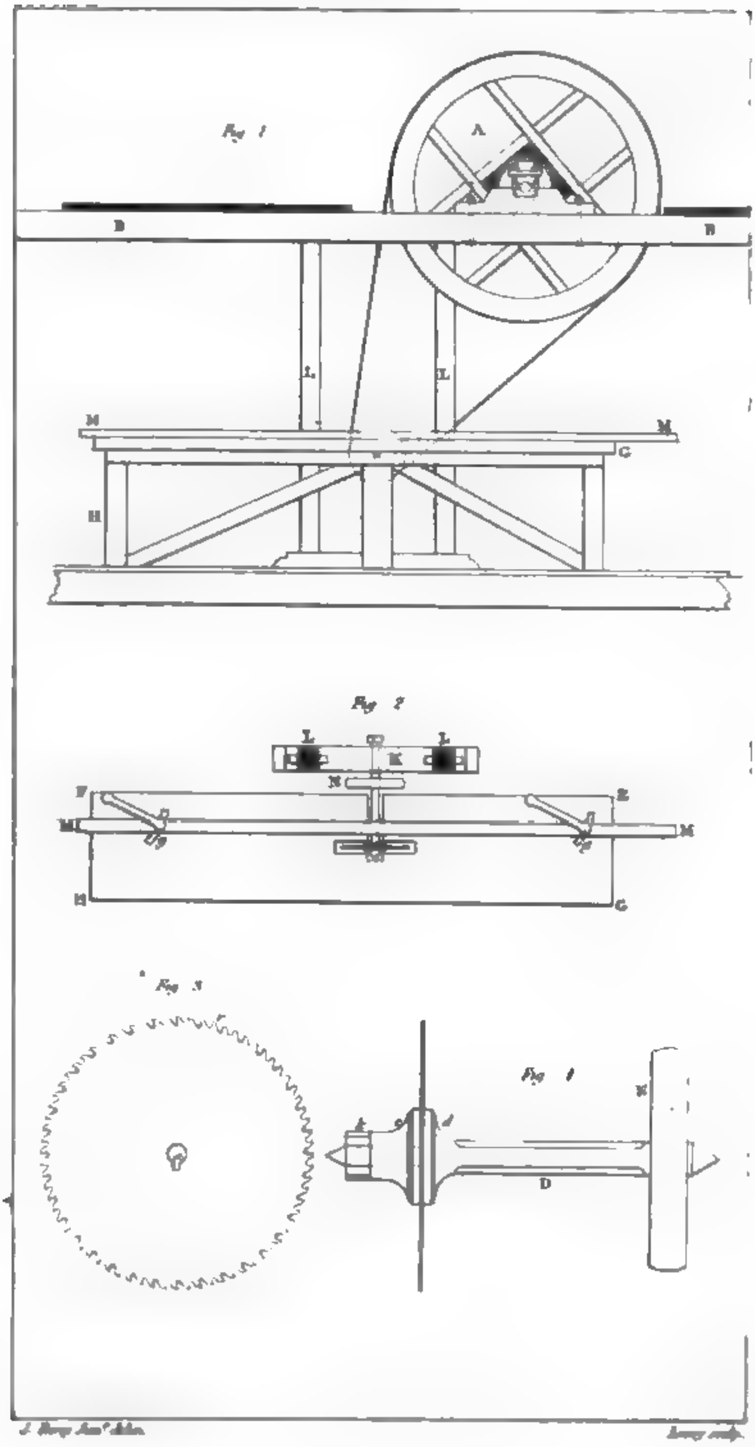
SAW MILL.



London. Published by Longman, Hurst, Rees & Orme, Aug. [illegible]

Hawkins's Scotograph,

or machine for writing in the dark

SHORT-HAND.

The Alphabet,

Invented by John Byrom, M.A. & F.R.S.

	Words.	Prepositions.	Terminations.
B	Be, but	Bi-	-ble or -able
d	And	De- dis-	-ed
f or v	Of	....	-ify
g	Again / Against	....	....
h	Have, had		....
j	Judge, just		
k	Can / Could	Com- or con- / Contra-	-ical
l	All, always, altogether	..	....
m	Am / Amongst	Magni- / Mis- / Omni-	-ment, -ments
n	An / In / Under	Ante- or anti- / In- or inter- / Un- or under-	-ence / -ent / -ness
p	Upon	Per- pre- or pro-	
q	Question	....	....
r	Or	Re-	-ary; -ing, -ings
s or z	As / Is / Us	Satis- / Circum- / Sub- or super-	-ation / -etion / -ition / -otion / -ution; -self / -selves
t	The	Trans-	-ity; -ities
w	Will, would	With-	-ward, -wards
x	Except, exercise	Ex- extra-	....
y	Yet		
ch	Which		
sh	Shall, should		-ship, -ships
th	That		
etc	&c.		

Vowels' Places.

aa, ea, &c. — ua, ue, &c. — ai, ei, &c. — iu, ii, &c.

am, em, &c. — ma, me, &c. — an, en, &c. — na, ne, &c.

Figures.

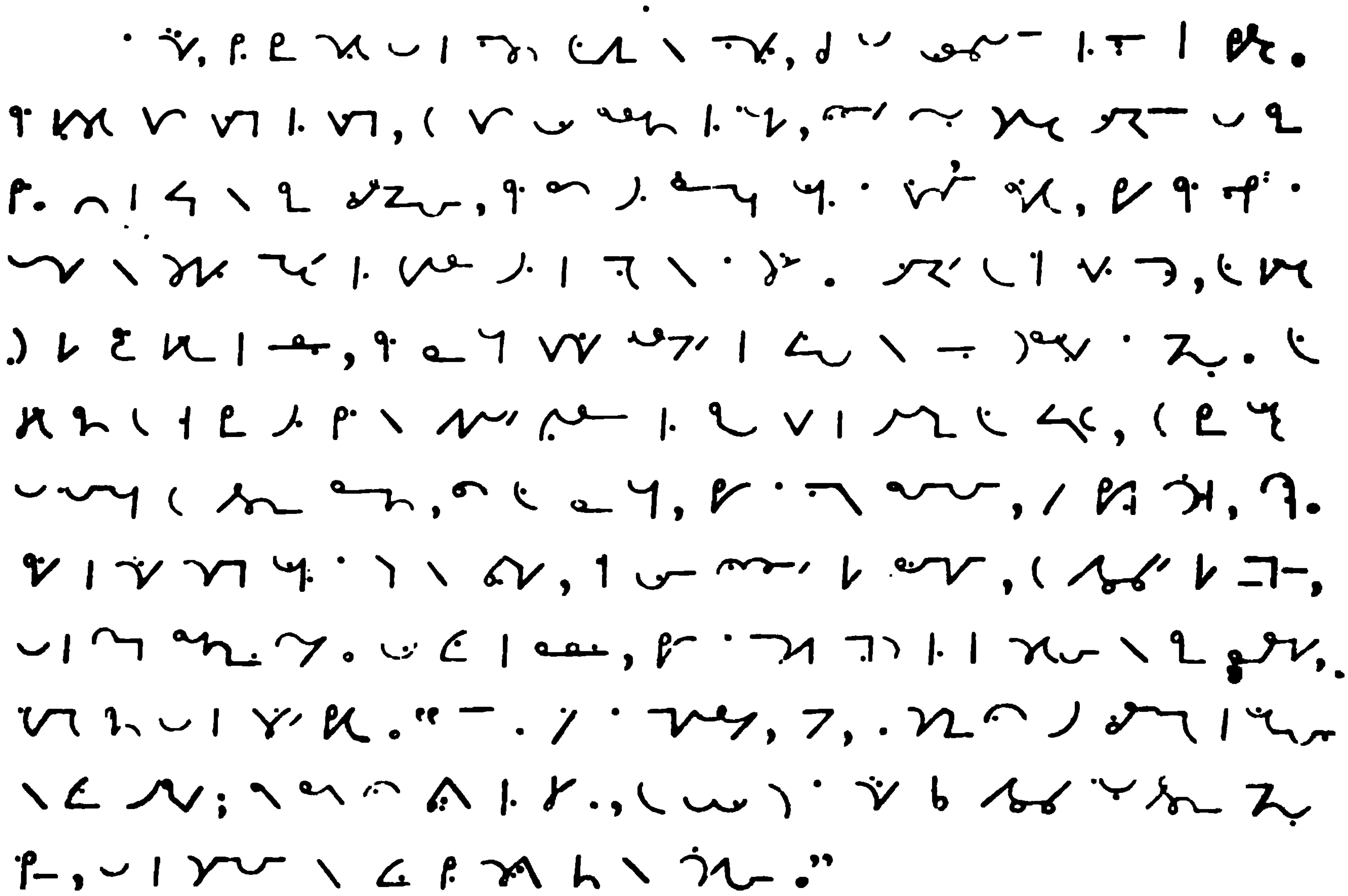
1 2 3 4 5 6 7 8 9 0

London. Published by Longman, Hurst, Rees, ...

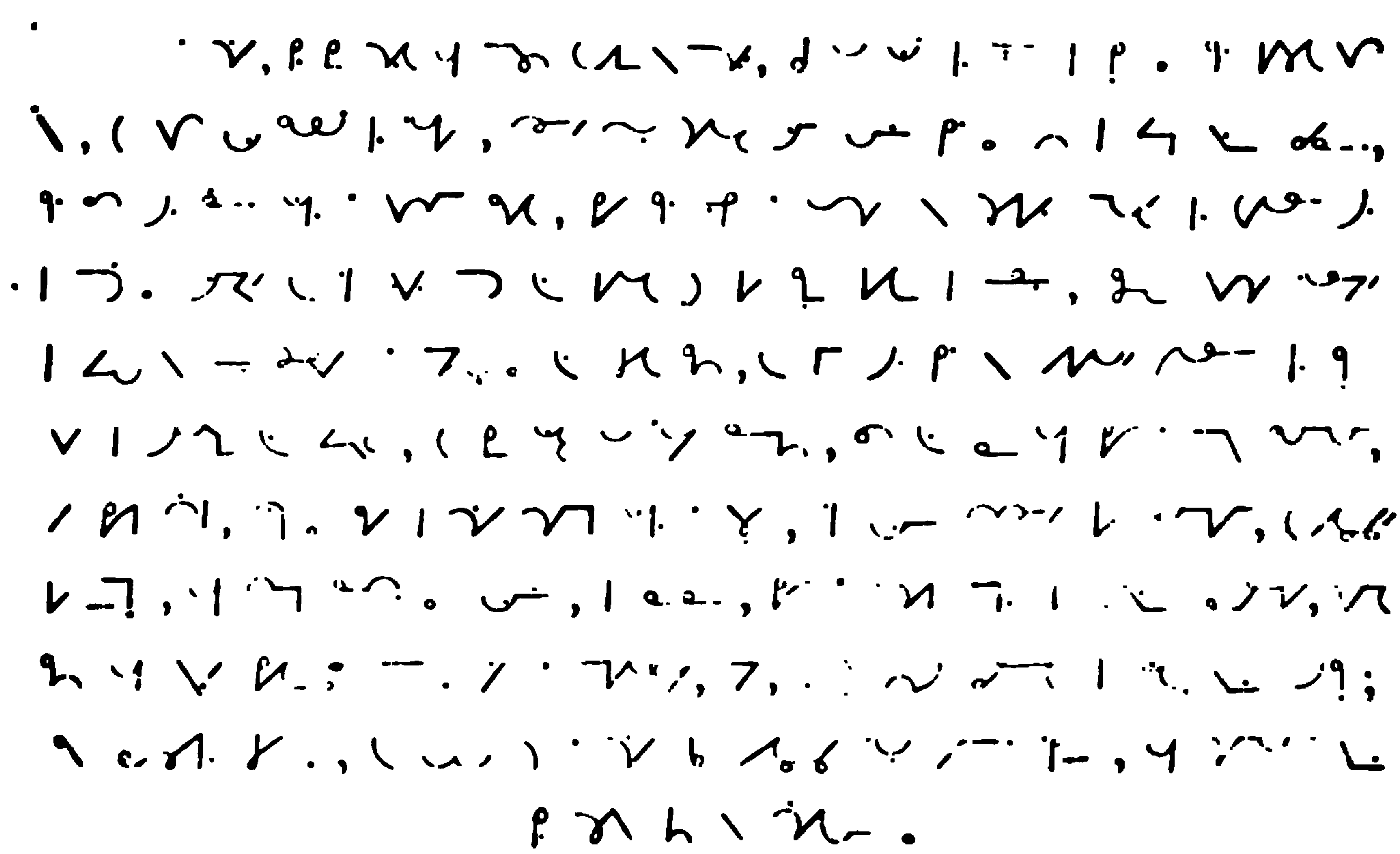
SHORT-HAND.

Specimens.

The Bear. A Fable.

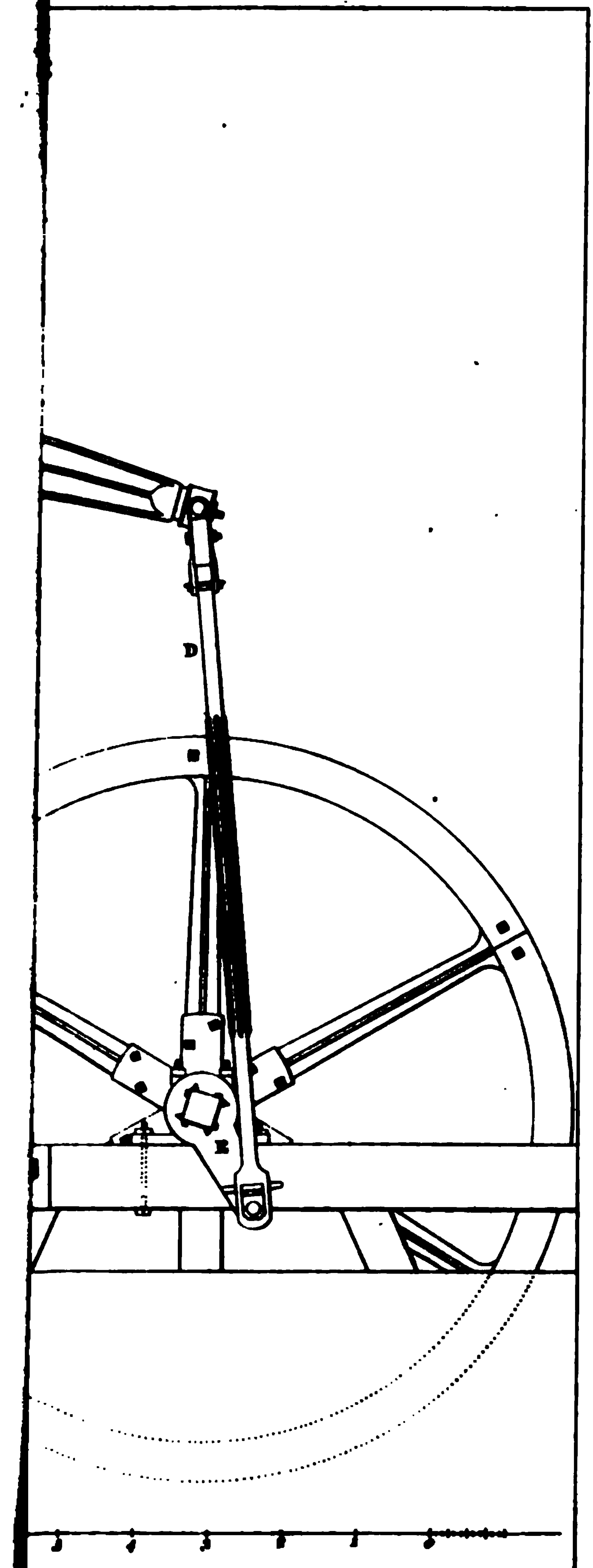


The Same With Contractions.



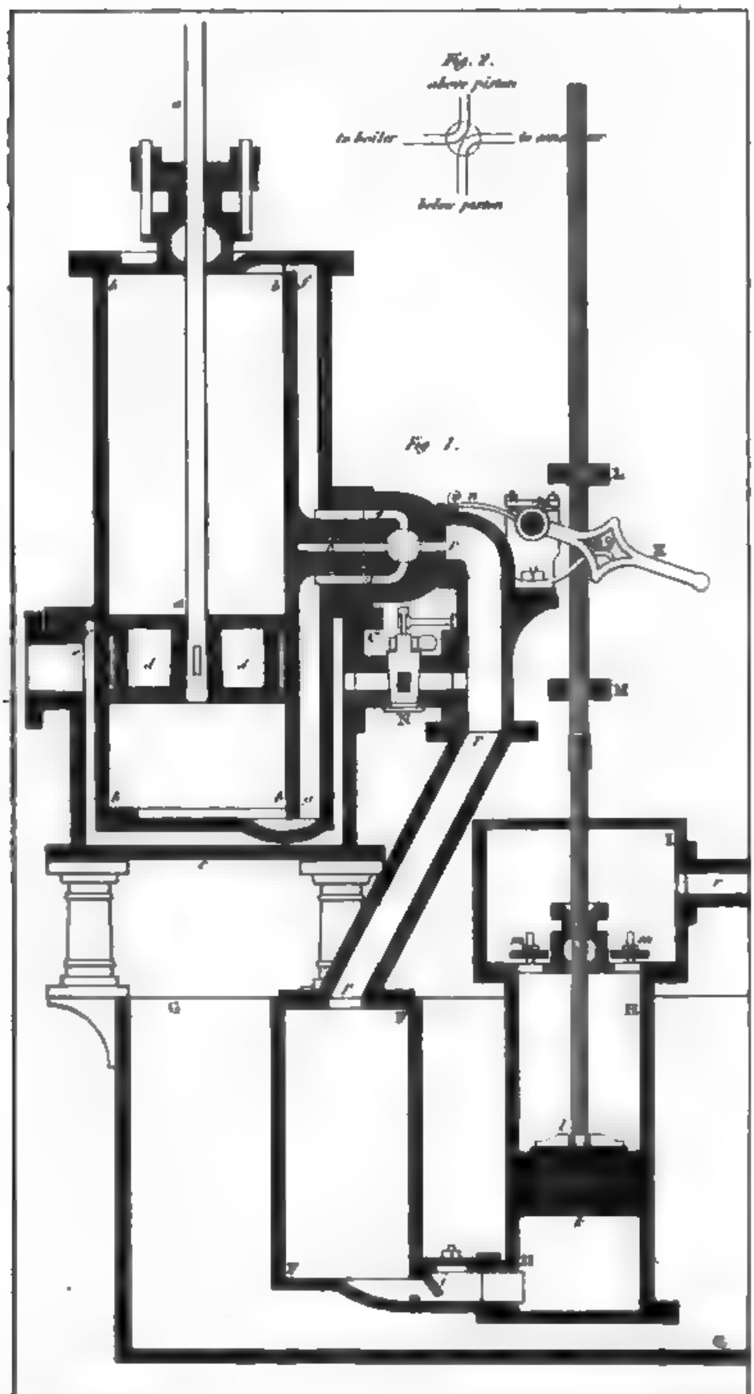
London. Published by Longman, Hurst, Rees, & Orme, July 1 [illegible]

Maid Lane



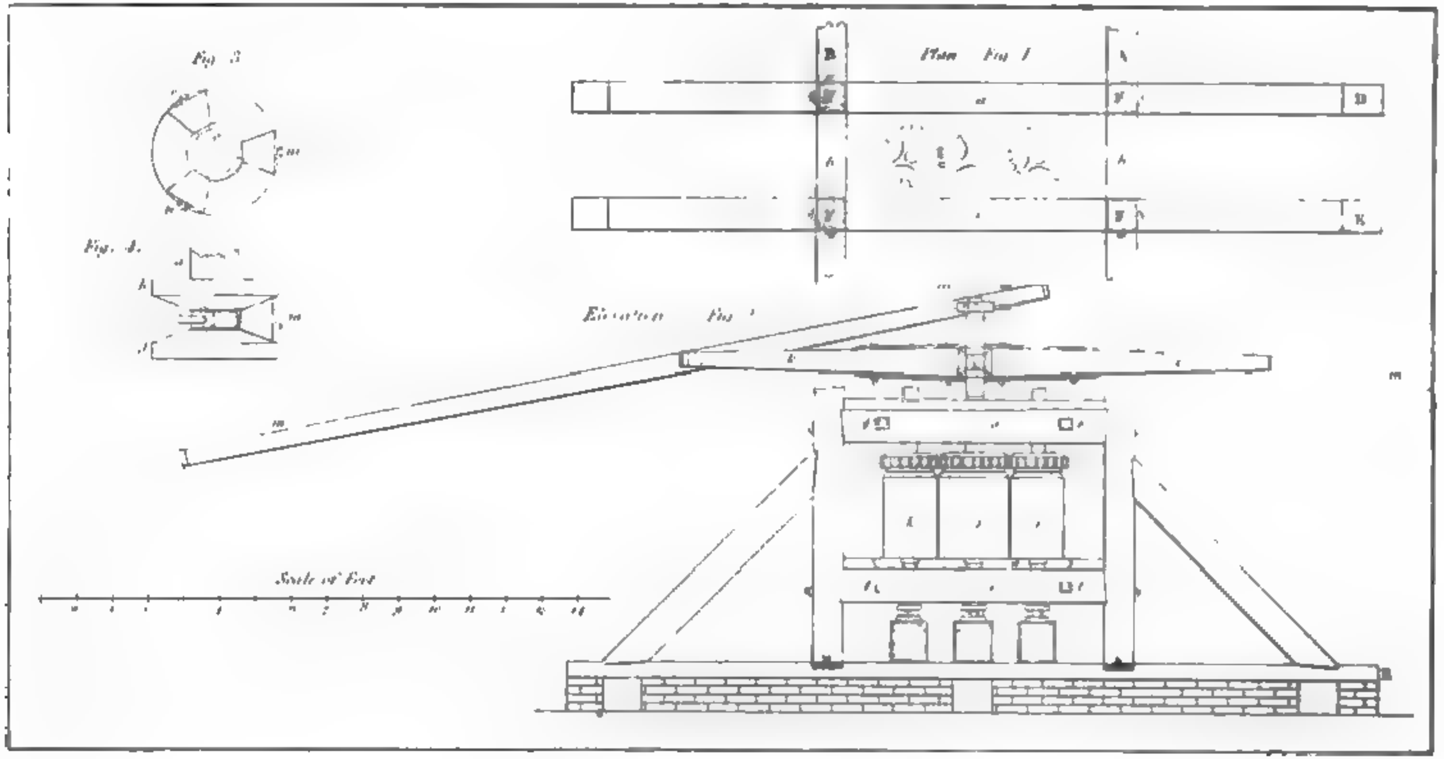
Lowry sculp.

Section of Cylinder and pipes of Dixons Steam Engine.



London. Published by Longman, Hurst, Rees & Orme.

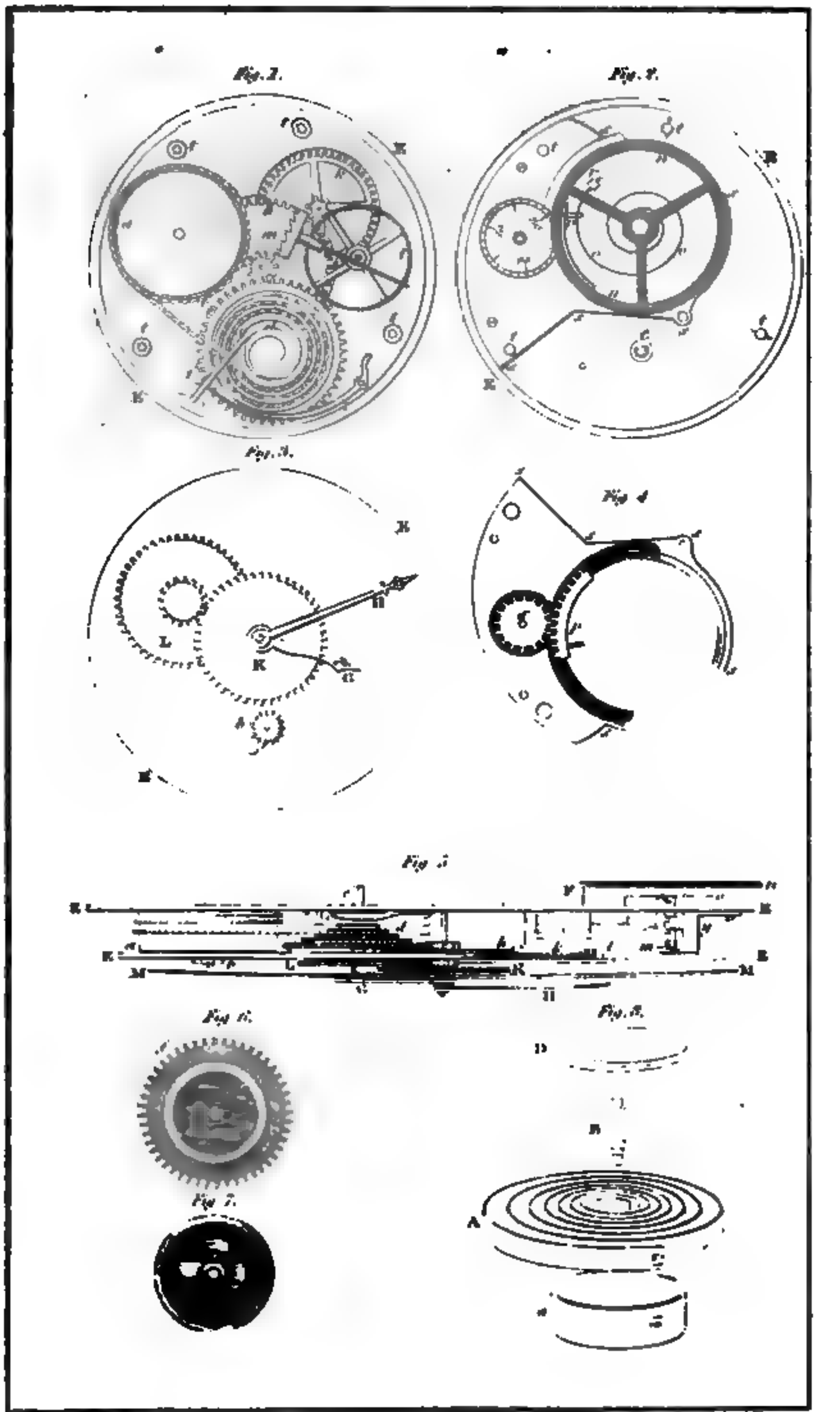
SUGAR MILL by Mr THOS ROWNTREE.



J. Farey Junr. delin. Lowry sculp.

London, Published by Longman, Hurst, Rees & Orme

WATCH.



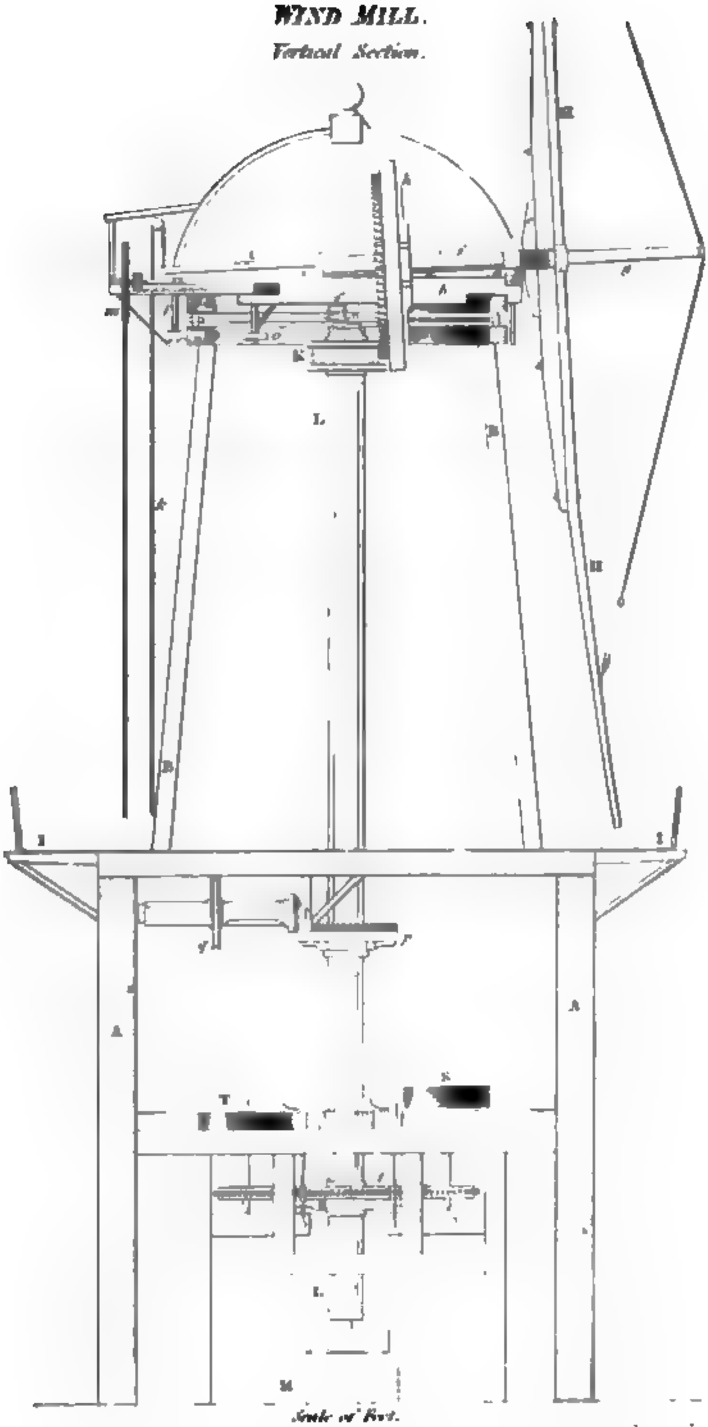
J. Farey Junr. delin.

Lowry sculp.

London, Published by Longman, Hurst, Rees & Orme [illegible].

WIND MILL.

Vertical Section.



Scale of Feet.

J. Farey Junr. delin. — Lowry sculp.

London Published by Longman Hurst Rees & Orme [illegible]